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ABSTRACT

The curriculum guide for welding instruction contains 16 units presented in six sections. Each unit is divided into the following areas, each of which is color coded: terminal objectives, specific objectives, suggested activities, and instructional materials; information sheet; transparency masters; assignment sheet; test; and test answers. The first three sections, which provide an introduction to welding, are: Introduction (safety, orientation to welding, and metals); Related Information (Vocational Industrial Clubs of America, parliamentary procedure and public speaking, becoming a good leader, applying for a job, and measuring); and Blueprints (basic blueprint reading). The remaining three sections, which provide practical welding experience and which comprise approximately two-thirds of the document, are: Cxyacetylene Welding (oxyacetylene cutting, oxyacetylene fusion welding, and oxyacetylene braze welding); Arc Welding (sheet metal arc welding and sheet metal arc welding position welding); and Gas Arc Welding (gas tungsten arc welding and gas metal arc welding). The units in the last three sections also include job sheets with directions for specific welding projects. (JR)

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FOREWORD

This publication is designed to provide a basic core of welding instruction for vocational education in Oklahoma.

Today teachers of vocational education are faced with increasing problems of what to teach and whom to serve. The student of today, who will be the craftsman of tomorrow, needs to be a well-educated individual who is constantly seeking information on which to base the many decisions he is required to make.

The purpose of this curriculum guide is to assist instructors in improving welding instruction in Oklahoma. Appreciation is expressed to the many individuals who helped in the development of this publication. The teaching of welding should become more effective with the use of this curriculum guide.

Francis T. Tuttle, State Director
State Department of Vocational and
Technical Education

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ACKNOWLEDGMENTS

Appreciation is expressed to the many individuals who gave their time and knowledge to the development of the first publication and to this revision.

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USE OF THIS PUBLICATION

Instructional Units

The Welding Curriculum includes six areas. Each area consists of one or more units of instruction. Each instructional unit includes behavioral objectives, suggested activities for teacher and student, information sheets, assignment sheets, job sheets, transparency masters, test, and answers to the test. Units are planned for more than one lesson or class period of instruction.

Careful study of each instructional unit by the teacher will help him determine:

A. The amount of material that can be covered in each class period.
B. The skills which must be demonstrated.
    1. Supplies needed
    2. Equipment needed
    3. Amount of practice needed
    4. Amount of class time needed for demonstrations
C. Supplementary materials such as pamphlets and filmstrips that must be ordered.
D. Resource people that must be contacted.

Objectives

Each unit of instruction is based on behavioral objectives. These objectives state the goals of the course thus providing a sense of direction and accomplishment for the student.

Behavioral objectives are stated in two forms: Terminal Objectives stating the subject matter to be covered in a unit of instruction; Specific Objectives stating the student performance necessary to reach the terminal objective.

Since the objectives of the unit provide direction for the teaching-learning process, it is important for the teacher and students to have a common understanding of the intent of the objectives. A limited number of performance terms have been used in the objectives for this curriculum to assist in promoting the effectiveness of the communication among all individuals using the materials.

Following is a list of performance terms and their synonyms which were used in this material:

Name
Label
List in writing
List orally
Letter
Record
Repeat
Give

Identify
Select
Mark
Point out
Pick out
Choose
Locate

Describe
Define
Discuss in writing
Discuss orally
Interpret
Tell how
Tell what
Explain

Order
Arrange
Sequence
List in order
Classify
Divide
Isolate
Sort

Distinguish
Discriminate

Construct
Draw
Make
Build
Design
Formulate
Reproduce
Transcribe
Reduce
Increase
Figure
Cost

Demonstrate
Show your work
Show procedure
Perform an experiment
Perform the steps
Operate
Remove
Replace
Turn off/on
(Dis) assemble
(Dis) connect

Reading of the objectives by the student should be followed by a class discussion to answer any questions concerning performance requirements for each instructional unit.

Teachers should feel free to add objectives which will fit the material to the needs of his students and community. When a teacher adds objectives, he should remember to supply the needed information, assignment and/or job sheets, and criterion tests.

Suggested Activities

Each unit of instruction has a Suggested Activities sheet outlining steps to follow in accomplishing specific objectives. The activities are listed according to whether they are the responsibility of the instructor or the student.

Instructor: Duties of the instructor will vary according to the particular unit; however, for best use of the material they should include the following: provide students with objective sheet, information sheets, assignment sheets, and job sheets; preview filmstrips, make transparencies, and arrange for resource materials and people; discuss terminal and specific objectives and information sheets; give test. Teachers are encouraged to use any additional instructional activities and teaching methods to aid students in accomplishing the objectives.

Students: Student activities are listed which will help the student to achieve the objectives for the unit.

Information Sheets

Information sheets provide content essential for meeting the cognitive (knowledge) objectives of the unit. The teacher will find that information sheets serve as an excellent guide for presenting the background knowledges necessary to develop the skills specified in the terminal objective.

Students should read the information sheets before the information is discussed in class. Students may take additional notes on the information sheets.

Transparency Masters

Transparency masters provide information in a special way. The students may see as well as hear the material being presented, thus reinforcing the learning process. Transparencies may present new information or they may reinforce information presented in the information sheets. They are particularly effective for such activities as learning and locating the parts of a machine.

Transparencies should be made and placed in the notebook where they will be immediately available for use. Transparencies direct the class's attention to the topic of discussion. They should be left on the screen only when topics shown are under discussion. (NOTE: Stand away from the overhead projector when discussing transparency material. The noise of the projector may cause the teacher to speak too loudly.)

Job Sheets

Job sheets are an important segment of each unit. The instructor should be able to and in most situations should demonstrate the skills outlined in the job sheets. Procedures outlined in the job sheets give direction to the skill being taught and allow both student and teacher to check student progress toward the accomplishment of the skill. Job sheets provide a ready outline for a student to follow if he has missed a demonstration. Job sheets also furnish potential employers with a picture of the skills being taught and the performances he might reasonable expect from a person who has had this training.

Assignment Sheets

Assignment sheets give direction to study and furnish practice for paper and pencil activities to develop the knowledges which are necessary prerequisites to skill development. These may be given to the student for completion in class or used for homework assignments. Answer sheets are provided which may be used by the student and/or teacher for checking student progress.

Test and Evaluation

Paper-pencil and performance tests have been constructed to measure student achievement of each objective listed in the unit of instruction. Individual test items may be pulled out and used as a short test to determine student achievement of a particular objective. This kind of testing may be used as a daily quiz and will help the teacher spot difficulties being encountered by students in their efforts to accomplish the terminal objective. Test items for objectives added by the teacher should be constructed and added to the test. Progress sheets are provided for student and teacher to record acceptable performance of skills outlined in job sheets.

Test Answers

Test answers are provided for each unit. These may be used by the teacher and/or student for checking student achievement of the objectives.

SAFETY
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to recognize unsafe situations and be able to state rules for shop and personal safety. He should be able to select the correct fire extinguisher for the classes of fire and match the safety color code with statements of its use. The student should be willing to sign the safety pledge form and should make at least ninety percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define the terms safety, accident, and first aid.
2. Match the six colors of the safety color code with statements of their use.
3. List five rules for personal safety.
4. List eight rules for general shop safety.
5. List five steps in maintaining a clean and orderly shop.
6. Match the four classes of fire with statements defining each class.
7. List the three components of the fire triangle.
8. Select from a list of fire extinguishers the types best suited to extinguish each class of fire.
9. List ten general welding safety precautions or rules.
10. Indicate a willingness to work safely by subscribing to the student safety pledge form.

SAFETY
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

- A. Provide students with objective sheet.
- B. Provide students with information sheet and the safety pledge form.
- C. Make transparencies.
- D. Discuss terminal and specific objectives.
- E. Discuss information sheet.
- F. Give test.

II. Student:

- A. Read objective sheet.
- B. Study information sheet.
- C. Complete the safety pledge form.
- D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

- A. Objective sheet
- B. Information sheet
- C. Transparency masters
  - 1. TM 1--The Fire Triangle
  - 2. TM 2--Types of Fire Extinguishers
- D. Assignment Sheet #1--Student Safety Pledge Form
- E. Test
- F. Answers to test

II. References:

A. *The ABC's of Fire Protection.* Belleville, New Jersey: Kidde Portable Extinguishers, Walter Kidde and Company, Inc.

B. *An Accident Prevention Program for School Shops and Laboratories.* U.S. Department of Health, Education, and Welfare, Office of Education.

C. *Federal Register.* Department of Labor. Vol. 36. Number 105. Part II. May 29, 1971.

D. *Safety Practices and Procedures in School Shops.* Department of Education, Division of Vocational Education, State of New Jersey.

E. *Hobart General Welding Safety Rules.* Troy, Ohio: Hobart Arc Welding.

SAFETY
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Safety--State or condition of being safe; freedom from danger, risk, or injury

   B. Accident--Includes any suddenly occurring, unintentional event which causes injury or property damage

   C. First aid--Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

II. Colors and application of the safety color code

   A. Federal safety red--Basic color for the identification of:

      1. Fire protection equipment and apparatus

      2. Portable containers of flammable liquids

      3. Emergency stop bars, stop buttons, and emergency electrical stop switches on machinery

   B. Federal safety yellow--Basic color for designating:

      1. Caution and for marking physical hazards

      2. Waste containers for explosive or combustible materials

      3. Caution against starting, using or moving equipment under repair

      4. Identification of the starting point or power source of machinery

   C. Federal safety orange--Basic color for designating:

      1. Dangerous parts of machines

      2. Safety starter buttons

      3. The exposed parts (edges only) of pulleys, gears, rollers, cutting devices, and power jaws

   D. Federal safety purple--Basic color for designating radiation hazards

   E. Federal safety green--Basic color for designating:

      1. Safety

INFORMATION SHEET

    2. Location of first aid equipment

       (NOTE: This applies to equipment other than fire fighting equipment.)

  F. Federal safety black and white--(used individually or in combination) Basic colors for designating:

    1. Traffic flow

    2. Housekeeping purposes

III. Personal safety rules

  A. Wear shop clothing appropriate to the instructional activity being performed

  B. Confine long hair before operating rotating equipment

  C. Always wear safety glasses; use suitable helmets and goggles for welding

  D. Remove ties when working around machine tools or rotating equipment

  E. Remove rings and other jewelry when working in the shop

  F. Conduct yourself in a manner conducive to safe shop practices

  G. Use soap and water frequently as a method of preventing skin diseases

IV. General shop safety rules

  A. Keep all hand tools sharp, clean, and in safe working order

  B. Report any defective tools, machines, or other equipment to the instructor

  C. Retain all guards and safety devices except with the specific authorization of the instructor

  D. Operate a hazardous machine only after receiving instruction on how to operate the machine safely

  E. Report all accidents to the instructor regardless of nature or severity

  F. Turn off the power before leaving a machine tool

  G. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool

  H. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning

INFORMATION SHEET

- I. Use a solvent only after determing its properties, what kind of/work it has to do, and how to use it
- J. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held
- K. Keep the shop or laboratory floor clear of scraps and litter
- L. Clean up any spilled liquids immediately
- M. Oily rags or oily waste should be stored in metal containers
- N. Clean the chips from a machine with a brush--not with a rag or the bare hands

V. Steps in maintaining a clean and orderly shop

- A. Machinery and equipment arranged to permit safe efficient work practices and ease in cleaning
- B. Materials and supplies safety stacked or stored in proper place
- C. Tools and accessories safely stored in cabinets, on racks, or other suitable devices
- D. Working areas and work benches clear and free of debris and other hazards
- E. Floors clean and free from obstructions and slippery substances
- F. Aisles, traffic areas, and exits free of materials and other debris
- G. Combustible materials properly disposed of or stored in approved containers
- H. Oily rags stored in self-closing or spring-lid metal containers
- I. Students working in the area instructed on the proper procedures to follow in keeping the area clean and orderly
- J. Sufficient brooms, brushes, and other housekeeping equipment readily available

VI. Classes of fires

- A. Class A--Fires that occur in ordinary combustible materials, such as wood, rags, and rubbish
- B. Class B--Fires that occur with flammable liquids, such as gasoline, oil, grease, paints, and thinners

INFORMATION SHEET

   C. Class C--Fires that occur in or near electrical equipment such as motors, *switchboards, and electrical wiring*

   D. Class D--Fires that occur with combustible metals such as magnesium

VII. Three components of the fire triangle (Transparency 1)

   A. Fuel--Any combustible material

   B. Heat--Enough to raise the fuel to its ignition temperature

   C. Oxygen--Necessary to sustain combustion

   (NOTE: To produce fire these three elements are necessary and must be present at the same time.)

   (NOTE: If any one of the three is missing, a fire cannot be started or, with the removal of any one of them, the fire will be extinguished.)

VIII. Types of fire extinguishers (Transparency 2)

   A. Pressurized water--Operates usually by squeezing a handle or trigger; used on Class A fires

   B. Soda acid--Operates by turning extinguisher upside down; used on Class A fires

   C. Carbon dioxide (CO_2)--Operates usually by squeezing handle or trigger; used on Class B and C fires

   D. Dry chemical--Operates usually by squeezing a handle, trigger, or lever; used on Class B, C, and D fires

   (NOTE: On Class D fires, dry sand is as effective as any dry chemical other than Purple X. The cost of the Purple X chemical places it out of reach of most shops.)

   E. Foam--Operates by turning extinguisher upside down; used on Class A and B fires

IX. General welding safety precautions or rules

   A. Always wear suitable protective clothing

   B. Always keep a safe, clean work area

   C. Make sure there are no flammable materials near

   D. Do not weld in the vicinity of explosive materials nor near carbon tetrachloride

INFORMATION SHEET

E. Always make sure you have enough ventilation to give three or four complete changes of air per hour

F. Use air exhaust at the weld whenever welding lead, cadmium, chromium, manganese, brass, bronze, zinc, or galvanized metals

G. Never weld or cut in a confined area without protection

H. Handle inert gas cylinders with the same care you use with oxyacetylene cylinders

I. Keep all welding equipment in good condition

J. If it is necessary to couple lengths of cable together, make sure joints are insulated and all electrical connections are tight; use no cables with frayed, cracked, or bare spots

K. When electrode holder is not in use, hang it on welding machine or special holder; never let it touch a gas cylinder

L. Always have welding machine properly grounded

M. Make sure pedal controls are guarded to prevent accidental starts

N. If need arises to weld in damp or wet conditions, wear rubber boots and/or stand on dry cardboard or wood

O. Stand only on solid items, floor or ground

P. When welding in high places without railings, use safety belt or lifeline

Q. Always wear proper eye protection, especially when grinding or cutting

R. Keep your booth curtains closed to protect the eyes of others

S. Never weld or cut directly on a concrete floor

T. When using a water-cooled torch, check for water leakage

U. Do not use oil or grease on any oxygen or acetylene connections as oil and oxygen will ignite

V. Never open tank valves until you are certain that regulator valves are closed

W. Never open the valves on the cylinders with a hammer

X. Never hammer on oxygen or acetylene regulators

Y. Do not light a torch with a match or open flame; use lighter provided

INFORMATION SHEET

Z. Before lighting torch, be positive that hose, tanks, or any inflammable material will not be exposed to heat, flame, or sparks

AA. Beware of high acetylene pressure; never use acetylene-gas when the pressure is greater than fifteen pounds per square inch

(NOTE: Acetylene gas when compressed to more than fifteen pounds becomes a very high explosive.)

BB. Never screw the regulator screw in tight against the regulator as this spoils the diaphragm; if hose pressure drops, check tank pressure at regulator; tank is probably empty

CC. Do not hold welding or cutting tip too close to your work; this will cause a flash-back in your torch

DD. Never use a tip that gets hot

EE. Never use a torch that leaks

FF. Never leave your torch burning and go away from it

GG. Never leave torch valve open

HH. Do not use the torch for a hammer, crowbar, wedge, or for any other purpose than welding; do not use a cylinder, even when empty, as a roller

II. Do not store cylinders in a room where the temperature is more than eighty degrees

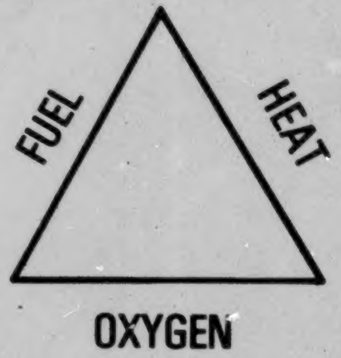
JJ. Do not adjust, alter, change, build, or do any experimental work on cylinders, regulators, torches, or any other gas equipment

KK. Never attempt to weld a closed or jacketed tank, vessel, or container without a vent for air

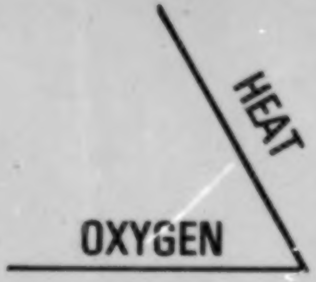
(NOTE: Even with a vent, great care should be used not to get gas in tank. If for any reason you should get gas in the tank, be sure to aerate the tank.)

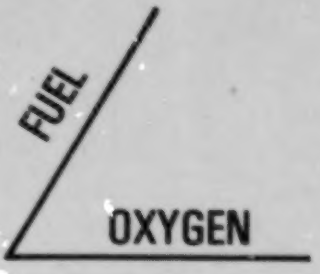
The Fire Triangle

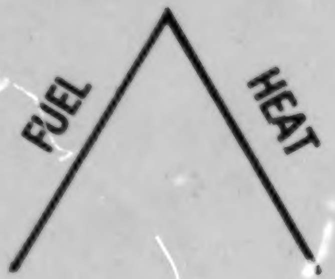
To produce fire, three things must be present at the same time.


FUEL
HEAT
OXYGEN

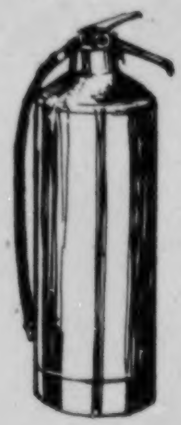
If any one of the three is missing, a fire cannot be started or, with the removal of any one, the fire will be extinguished.


HEAT
OXYGEN

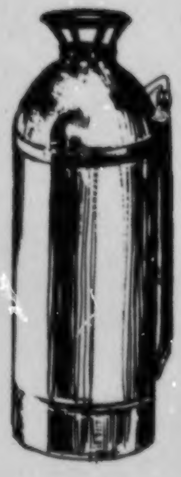

FUEL
OXYGEN



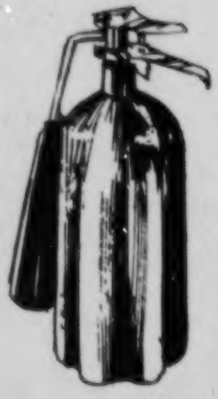
Types of Fire Extinguishers



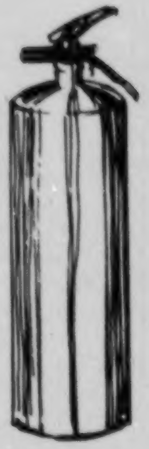
Pressurized
Water



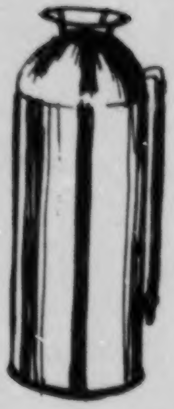
Soda-Acid



Carbon
Dioxide



Dry
Chemical



Foam

SAFETY
UNIT I

ASSIGNMENT SHEET #1--STUDENT SAFETY PLEDGE FORM

___________ ___________ ___________, who is enrolled in Vocational ___________

__________, will as part of his shop experience, operate machines, providing that his

parent or guardian gives written permission.

It is understood that each student will be given proper instruction, both in the use of the equipment and in correct safety procedures concerning it, before being allowed to operate it himself. The student must assume responsibility for following safe practices, and we therefore ask that he subscribe to the following safety pledge.

1. I promise to follow all safety rules for the shop.
2. I promise never to use a machine without first having permission from the instructor.
3. I will not ask permission to use a particular machine unless I have been instructed in its use, and have made 100% on the safety test for that machine.
4. I will report any accident or injury to the teacher immediately.

Date___________Student's signature___________ ___________ ___________

I hereby give my consent to allow my son to operate all machines and equipment necessary in carrying out the requirements of the course in which he is enrolled.

Date___________Parent's signature___________ ___________ ___________

Parents are cordially invited to visit the shop to inspect the machines and to see them in operation.

SAFETY
UNIT I

TEST

1. Define the following terms.

   a. Safety--

   b. Accident--

   c. First aid--

2. Match the following colors of the safety color code with the correct statements of their use.

   ______a. Designates caution

   ______b. Used to identify the location of fire fighting equipment

   ______c. Designates the location of safety and first aid equipment

   ______d. Designates dangerous parts of equipment which may cut, crush, shock, or otherwise injure

   ______e. Designates caution against starting equipment while it is being worked on or against the use of defective equipment

   ______f. Designates traffic flow

   ______g. Designates radiation hazards

   1. Green
   2. White
   3. Orange
   4. Purple
   5. Black
   6. Red
   7. Yellow

3. List five personal safety rules.

   a.

   b.

   c.

   d.

   e.

4. List eight rules for general shop safety.

   a.

   b.

c.

d.

e.

f.

g.

h.

5. List five steps in maintaining a clean and orderly shop.

a.

b.

c.

d.

e.

6. Match the classes of fire with the correct statement defining each class.

_____a. Fires that occur with flammable liquids such as gasoline, oil, or grease	1.	Class A
_____b. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish	2.	Class B
_____c. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring	3.	Class C
_____d. Fires that occur with combustible metals such as magnesium	4.	Class D

7. List the three components of the fire triangle.

a.

b.

c.

8. Write the number or numbers of the fire extinguisher best suited to extinguish each class of fire.

_____a. Fires that occur with flammable liquids such as gasoline, oil, or grease

_____b. Fires that occur in or near electrical equipment such as motors, switchboards, and electrical wiring

_____c. Fires that occur in ordinary combustible materials such as wood, rags, and rubbish

_____d. Fires that occur with combustible metals such as magnesium

1. Pressurized water
2. Carbon dioxide (CO_2)
3. Dry chemical
4. Soda acid
5. Foam

9. List ten general welding safety precautions or rules.

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

10. Indicate a willingness to work safely by subscribing to the student safety pledge form.

SAFETY
UNIT I

ANSWERS TO TEST

1. a. State or condition of being safe; freedom from danger, risk, or injury

   b. Includes any suddenly occuring, unintentional event which causes injury or property damage

   c. Immediate, temporary care given the victim of an accident or sudden illness until the services of a physician can be obtained

2. a. 7

   b. 6

   c. 1

   d. 3

   e. 7

   f. 2 and 5

   g. 4

3. Any five of the following

   a. Wear shop clothing appropriate to the instructional activity being performed

   b. Confine long hair before operating rotating equipment

   c. Always wear safety glasses; use suitable helmets and goggles for welding

   d. Remove ties when working around machine tools or rotating equipment

   e. Remove rings and other jewelry when working in the shop

   f. Conduct yourself in a manner conducive to safe shop practices

   g. Use soap and water frequently as a method of preventing skin diseases

4. Any eight of the following:

   a. Keep all hand tools sharp, clean, and in safe working order

   b. Report any defective tools, machines, or other equipment to the instructor

   c. Retain all guards and safety devices except with the specific authorization of the instructor

   d. Operate a hazardous machine only after receiving instruction on how to operate the machine safely

- e. Report all accidents to the instructor regardless of nature or severity
- f. Turn off the power before leaving a machine tool
- g. Make sure all guards and barriers are in place and adjusted properly before starting a machine tool
- h. Disconnect the power from machine tools before performing the maintenance task of oiling or cleaning
- i. Use a solvent only after determing its properties, what kind of work it has to do, and how to use it
- j. Use correct, properly fitting wrenches for nuts, bolts, and objects to be turned or held
- k. Keep the shop or laboratory floor clear of scraps and litter
- l. Clean up any spilled liquids immediately
- m. Oily rags or oily waste should be stored in metal containers
- n. Clean the chips from a machine with a brush--not with a rag or the bare hands

5. Any five of the following:
   - a. Machinery and equipment arranged to permit safe efficient work practices and ease in cleaning
   - b. Materials and supplies safety stacked or stored in proper place
   - c. Tools and accessories safely stored in cabinets, on racks, or other suitable devices
   - d. Working areas and work benches clear and free of debris and other hazards
   - e. Floors clean and free from obstructions and slippery substances
   - f. Aisles, traffic areas, and exits free of materials and other debris
   - g. Combustible materials properly disposed of or stored in approved containers
   - h. Oily rags stored in self-closing or spring-lid metal containers
   - i. Students working in the area instructed on the proper procedures to follow in keeping the area clean and orderly
   - j. Sufficient brooms, brushes, and other housekeeping equipment readily available

6. a. 2

b. 1

c. 3

d. 4

7. a. Fuel

   b. Heat

   c. Oxygen

8. a. 2, 3, and 5

   b. 2 and 3

   c. 1 and 4

   d. 3

9. Any ten of the following

   a. Always wear suitable protective clothing

   b. Always keep a safe, clean work area

   c. Make sure there are no flammable materials near

   d. Do not weld in the vicinity of explosive materials nor near carbon tetrachloride

   e. Always make sure you have enough ventilation to give three or four complete changes of air per hour

   f. Use air exhaust at the weld whenever welding lead, cadmium, chromium, manganese, brass, bronze, zinc, or galvanized metals

   g. Never weld or cut in a confined area without protection

   h. Handle inert gas cylinders with the same care you use with oxyacetylene cylinders

   i. Keep all welding equipment in good condition

   j. If it is necessary to couple lengths of cable together, make sure joints are insulated and all electrical connections are tight; use no cables with frayed, cracked, or bare spots

   k. When electrode holder is not in use, hang it on welding machine or special holder; never let it touch a gas cylinder

   l. Always have welding machine properly grounded

m. Make sure pedal controls are guarded to prevent accidental starts

n. If need arises to weld in damp or wet conditions, wear rubber boots and/or stand on dry cardboard or wood

o. Stand only on solid items, floor or ground

p. When welding in high places without railings, use safety belt or lifeline

q. Always wear proper eye protection, especially when grinding or cutting

r. Keep your booth curtains closed to protect the eyes of others

s. Never weld or cut directly on a concrete floor

t. When using a water-cooled torch, check for water leakage

u. Do not use oil or grease on any oxygen or acetylene connections; oil and oxygen will ignite

v. Never open tank valves until you are certain that regulator valves are closed

w. Never open the valves on the cylinders with a hammer

x. Never hammer on oxygen or acetylene regulators

y. Do not light a torch with a match or open flame; use lighter provided

z. Before lighting torch, be positive that hose, tanks, or any inflammable material will not be exposed to heat, flame, or sparks

aa. Beware of high acetylene pressure; never use acetylene-gas when the pressure is greater than fifteen pounds per square inch

bb. Never screw the regulator screw in tight against the regulator; this spoils the diaphragm; if hose pressure drops, check tank pressure at regulator; tank is probably empty

cc. Do not hold welding or cutting tip too close to your work; this will cause a flash-back in your torch

dd. Never use a tip that gets hot

ee. Never use a torch that leaks

ff. Never leave your torch burning and go away from it

gg. Never leave torch valve open

hh. Do not use the torch for a hammer, crowbar, wedge, or for any other purpose than welding; do not use a cylinder, even when empty, as a roller

ii. Do not store cylinders in a room where the temperature is more than eighty degrees

jj. Do not adjust, alter, change, build, or do any experimental work on cylinders, regulators, torches, or any other gas equipment

kk. Never attempt to weld a closed or jacketed tank, vessel, or container without a vent for air

10. Evaluated to the satisfaction of the instructor.

ORIENTATION TO WELDING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name the demand for all classes of welders within Oklahoma. He should be able to match the different welding processes with statements defining each and select the one or ones he would like to pursue upon finishing the course. He should be able to complete a social security application and obtain the card. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with welding to the correct definition.
2. Name two factors that influence the occupational outlook of welding.
3. Name the demand potential in Oklahoma for the different welding processes.
4. Match the types of welding processes with statements defining each.
5. Name three industries that employ welders.
6. Name four personal requirements for the welding program.
7. Name two items to consider in choosing a career.
8. Discuss in a short paragraph the importance to the welding trade of becoming a member of the VICA organization.
9. Name three activities in which a VICA member can participate.
10. Complete accurately the Social Security card application and obtain a Social Security number.
11. Complete a personal information sheet.

ORIENTATION TO WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

    A. Provide students with objective sheet.

    B. Provide students with information and personal information sheets.

    C. Discuss terminal and specific objectives.

    D. Discuss information sheet.

    E. Arrange for and take field trip to a welding program.

    F. Help students obtain a Social Security card.

    (NOTE: This might be possible by going to your post office and securing application forms.)

    G. Give test.

II. Students:

    A. Read objectives.

    B. Study information sheet.

    C. Complete personal information form and obtain a Social Security card.

    D. Participate in field trip.

    E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

    A. Objectives

    B. Information sheet

    C. Personal information form

    D. Test

    E. Answers to test

II. References:

A. *Official Guide for Vocational Industrial Clubs of America.* Vocational Industrial Clubs of America, Inc., 1025 15th Street N.W., Washington, D.C.

B. *Occupational Outlook Handbook.* U.S. Department of Labor, Bureau of Labor Statistics, Bulletin No. 1650, 1970-71 Edition.

C. *OTIS Report.* Division of Research Planning and Evaluation, State Department of Vocational and Technical Education, Stillwater, Oklahoma, 1972.

ORIENTATION TO WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Welding--A process of fastening metals together by means of interfusion

   B. Welding processes--The different methods of jointing metal together

      Examples: Arc, oxyacetylene, mig, tig

   C. Career--A course of continued progress in the life work of a person or progress through life in a series of related occupations or activities

   D. Occupation--A group of related jobs in an area of work which constitutes the work a person does regularly to make a living

   E. Occupational choice--A process one goes through eliminating some occupations and retaining others until an occupation has been chosen

   F. Job--A piece of work which is rather specific and definite in nature

II. Occupational outlook

   A. Expansion of welding within industry

   B. New methods of welding

   C. Self-employment

   D. Retirement and death within industry

   E. New industries

III. Oklahoma demand potential

	State number	Local or area number
A. Gas	92	
B. Arc	232	
C. Arc (machine operator)	93	
D. Tig	unavailable	

INFORMATION SHEET

E.	Mig	unavailable
F.	Combination	368

(NOTE: The above information was taken from the 1972 OTIS collection, which is compiled yearly by the Division of Research, Planning, and Evaluation, State Deptartment of Vocational and Technical Evaluation, Stillwater, Oklahoma. A combination welder is an individual proficient in the field of gas and arc welding. Tig and mig welding is a selective welding process and data is not available at this time on a state basis.)

IV. Types of welding processes

   A. Gas--Welding using a mixture of oxygen and acetylene and some form of filler rods

   B. Arc--Fusing two metals using an electric arc as the source of heat

   C. Gas tungsten (Tig)--Welding using a tungsten electrode and a shielding gas

   D. Metal inert gas (Mig)--Welding using a continuously fed consumable electrode and a shielding gas

V. Industries that employ welders

   A. Automobile and truck

   B. Aircraft

   C. Missile field

   D. Electronic equipment

   E. Building and bridge

   F. Household appliances

   G. Farm machinery

   H. Oil field

   I. Heavy equipment

   J. Tank and pipeline construction

   K. Ship building

   L. Metal fabrication plants

   M. Nuclear construction

INFORMATION SHEET

VI. Personal requirements for welding program

   A. Operate shop equipment correctly

   B. Follow safety rules

   C. Receive instruction readily and follow directions

   D. Be a good citizen

   E. Control temper

   F. Show enthusiasm about work

   G. Have pride in the trade

   H. Avoid waste of materials and man hours

   I. Provide self-discipline and restraint

   J. Strive for self-improvement

   K. Keep a neat appearance

VII. Choosing a career

   A. Likes, dislikes, and abilities

   B. Personal interests

   C. Occupations within welding trade

   D. Education and experience requirements

VIII. Importance of VICA

   A. Builds character

   B. Provides for leadership activities

   C. Allows for group participation

   D. Promotes citizenship and cooperation

   (NOTE: The welding trade is a vast and expanding industry that needs employees with the above mentioned qualifications. Research proves that most people lose their job because they are unable to adjust and get along with others regardless of the skill they have acquired.)

IX. VICA member activities

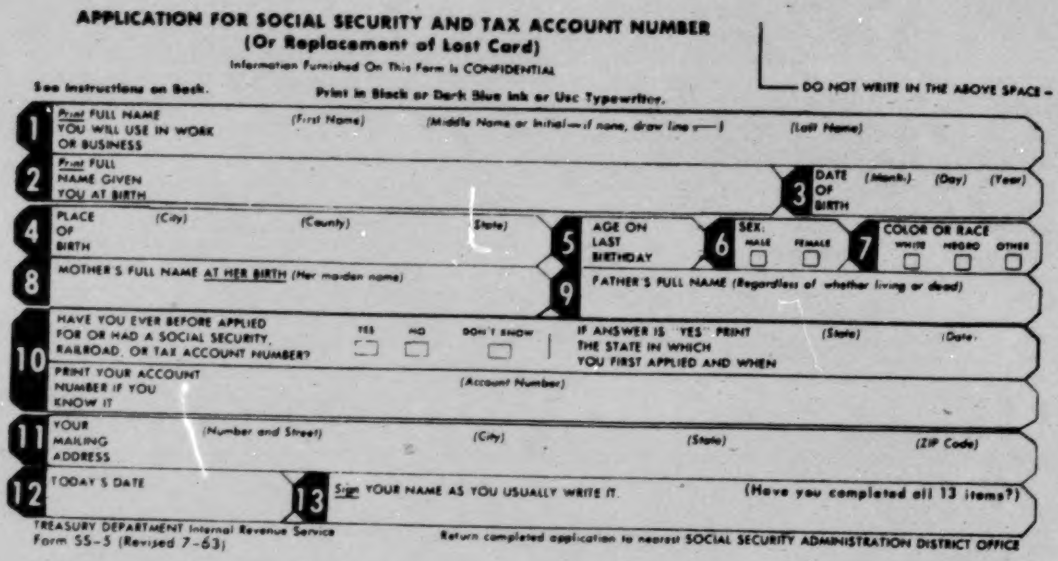
   A. Local, district, state, and national offices

   B. Public speaking

   C. Trade contests

INFORMATION SHEET

X. Social Security card application



APPLICATION FOR SOCIAL SECURITY AND TAX ACCOUNT NUMBER
(Or Replacement of Lost Card)
Information Furnished On This Form Is CONFIDENTIAL

DO NOT WRITE IN THE ABOVE SPACE –

See Instructions on Back.
Print in Black or Dark Blue Ink or Use Typewriter.

1 Print FULL NAME YOU WILL USE IN WORK OR BUSINESS (First Name) (Middle Name or Initial—if none, draw line —) (Last Name)

2 Print FULL NAME GIVEN YOU AT BIRTH

3 DATE OF BIRTH (Month) (Day) (Year)

4 PLACE OF BIRTH (City) (County) (State)

5 AGE ON LAST BIRTHDAY

6 SEX: MALE ☐ FEMALE ☐

7 COLOR OR RACE WHITE ☐ NEGRO ☐ OTHER ☐

8 MOTHER'S FULL NAME AT HER BIRTH (Her maiden name)

9 FATHER'S FULL NAME (Regardless of whether living or dead)

10 HAVE YOU EVER BEFORE APPLIED FOR OR HAD A SOCIAL SECURITY, RAILROAD, OR TAX ACCOUNT NUMBER? YES ☐ NO ☐ DON'T KNOW ☐
IF ANSWER IS "YES" PRINT THE STATE IN WHICH YOU FIRST APPLIED AND WHEN (State) (Date)
PRINT YOUR ACCOUNT NUMBER IF YOU KNOW IT (Account Number)

11 YOUR MAILING ADDRESS (Number and Street) (City) (State) (ZIP Code)

12 TODAY'S DATE

13 Sign YOUR NAME AS YOU USUALLY WRITE IT. **(Have you completed all 13 items?)**

TREASURY DEPARTMENT Internal Revenue Service
Form SS-5 (Revised 7-63)

Return completed application to nearest SOCIAL SECURITY ADMINISTRATION DISTRICT OFFICE

ORIENTATION TO WELDING
UNIT II

PERSONAL INFORMATION SHEET

Name: ______________________________ Age: __________

Home Address: ______________________ Birth Date: __________

Grade Classification: ______________________________

Occupational Objective: ______________________________

Social Security Number: ______________________________

Name of Parent's or Guardian: ______________________________

Address: ______________________________

Home Phone: ______________________________

Parent's or Guardian's Occupation: ______________________________

Family Doctor: ______________________________

Follow Up Information:

ORIENTATION TO WELDING
UNIT II

TEST

1. Match terms on the right with the correct definition.

_____a. A course of continued progress in the life work of a person or progress through life in a series of related occupations or activites

_____b. A process of fastening metals together by means of interfusion

_____c. A piece of work which is rather specific and definite in nature

_____d. The different methods of jointing metal together

_____e. A group of related jobs in an area of work which constitutes the work a person does regularly to make a living

_____f. A process one goes through eliminating some occupations and retaining others until an occupation has been chosen

1. Job
2. Occupational choice
3. Occupation
4. Welding
5. Career
6. Welding processes

2. Name two factors that influence the occupational outlook of welding.

a.

b.

3. Name the demand potential in Oklahoma for the following welding processes.

a. Gas: __________

b. Arc: __________

c. Arc (machine operator): __________

d. Tig: __________

e. Mig: __________

f. Combination: __________

4. Match the types of welding processes on the right with statements defining each.

______a. Fusing two metals together using an electric arc as the source of heat

______b. Welding using a continuously fed consumable electrode and a shielding gas

______c. Welding using a mixture of oxygen and acetylene and some form of filler rods

______d. Welding using a tungsten electrode and a shielding gas

1. Gas
2. Arc
3. Tig
4. Mig

5. Name three industries that employ welders.

a.

b.

c.

6. Name four personal requirements for the welding program.

a.

b.

c.

d.

7. Name two items to consider in choosing a career.

a.

b.

8. Discuss in a short paragraph the importance to the welding trade of becoming a member of the VICA organization.

9. Name three activities in which a VICA member can participate.

   a.

   b.

   c.

10. Complete accurately the Social Security card application and obtain a Social Security card

11. Complete a personal information sheet.

    (NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

ORIENTATION TO WELDING
UNIT II

ANSWERS TO TEST

1. a. 5
   b. 4
   c. 1
   d. 6
   e. 3
   f. 2
2. Any two of the following:
   a. Expansion of welding within industry
   b. New methods of welding
   c. Self-employment
   d. Retirement and death within industry
   e. New industries
3. a. 92
   b. 232
   c. 93
   d. Unavailable
   e. Unavailable
   f. 368
4. a. 2
   b. 4
   c. 1
   d. 3
5. Any three of the following:
   a. Automobile and truck
   b. Aircraft

  c. Missile field
  d. Electronic equipment
  e. Building and bridge
  f. Household appliances
  g. Farm machinery
  h. Oil field
  i. Heavy equipment
  j. Tank and pipeline construction
  k. Ship building
  l. Metal fabrication plants
  m. Nuclear construction

6. Any four of the following:
  a. Operate shop equipment correctly
  b. Follow safety rules
  c. Receive instruction readily and follow directions
  d. Be a good citizen
  e. Control temper
  f. Show enthusiasm about work
  g. Have pride in the trade
  h. Avoid waste of materials and man hours
  i. Provide self-discipline and restraint
  j. Strive for self-improvement
  k. Keep a neat appearance

7. Any two of the following:
  a. Likes, dislikes, and abilities
  b. Personal interests

    c. Occupations within welding trade
    d. Education and experience requirements

8. Discussion should include:
    a. Builds character
    b. Provides for leadership activities
    c. Allows for group participation
    d. Promotes citizenship and cooperation

9. a. Local, district, state, and national offices
    b. Public speaking
    c. Trade contests

10. Evaluated to the satisfaction of the instructor.

11. Evaluated to the satisfaction of the instructor.

METALS
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define terms associated with metals, identify shapes, and discuss the basics of metal identification. He should also be able to write a metals analysis. This will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define six terms associated with metals.
2. List common metals that can be welded.
3. Identify shapes of metals.
4. List four methods used for metal identification.
5. Identify the parts of the SAE/AISI numbering system for metals on a given code.
6. Classify metals as to ferrous or non-ferrous metals.
7. List the four basic types of carbon steels.
8. Discuss the importance of metallurgy.
9. Describe the difference between low alloy, high tensile steels and low carbon steels.
10. Discuss the properties of metals.
11. List five advantages of using aluminum in welding.
12. Discuss the major conditions that cause aluminum to be considered difficult to weld.
13. Write a metals analysis from given tables.

METALS
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information, assignment, and job sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Give test.

   (NOTE: Instructor should secure pamphlet from Lincoln Electric Co. *Weldirectory M210.*)

II. Students:

   A. Read objectives.

   B. Study information sheet and take notes.

   C. Complete assignment sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Provided in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency masters

      1. TM 1--Shapes of Metals

      2. TM 2--Methods of Identifying Metals

      3. TM 3--Methods of Identifying Metals (Continued)

      4. TM 4--SAE/AISI Designations

      5. TM 5--Identification Markings

D. Assignment Sheet #1--Write a Metal Analysis

E. Answers to assignment sheet

F. Test

G. Answers to test

II. References:

A. James F. Lincoln Arc Welding Foundation. *Metals and How to Weld them.* Cleveland, Ohio.

B. Feirer and Lindbeck. *Metalwork.* Second Edition. Peoria, Illinois: Charles A. Burnett Company, Inc.

C. Althouse, Turnguist, and Bowditch. *Modern Welding.* South Holland, Illinois: The Goodheart-Willcox Company, 1970.

D. Ludwig and McCarthy. *Metalwork Technology and Practice.* Fifth Edition. Bloomington, Illinois: McKnight and McKnight Publishing Company.

E. *Steel Supply Catalog and Reference Book.* Oklahoma City, Oklahoma: Steel Supply Company.

F. Johnson and Weeks. *Metallurgy.* Chicago, Illinois: American Welding Society, 1968.

G. *James F. Lincoln Arc Welding Lessons for School and Farm Shop.* Cleveland, Ohio: Arc Welding Foundation, 1964.

H. James F. Lincoln Arc Welding Foundation. *Weldirectory M210.* Cleveland, Ohio, 1972.

METALS
UNIT III

INFORMATION SHEET

I. Terms and definitions

  A. Metal--An element that has all or most of the following characteristics: solid at room temperature; opaque; conductor of heat and electricity; reflective when polished; expands when heated and contracts when cooled

  B. Alloy--Material having metallic characteristics and made up of two or more elements, one of which is a metal

  C. Metallurgy--The science and technology of extracting metals from ores, refining them, and preparing them for use

  D. Physical metallurgy--That division of metallurgy applying to the changes in structure and properties of metals as a result of shading, fabricating, and treating

  E. Process metallurgy--That division of metallurgy applying to the extracting, refining, and primary shaping of metals into a useable form

  F. Ore--The rock or earth in which we find metals in their natural form

  G. Ferrous--Dominated by iron (Fe) in its chemical composition

  H. Non-ferrous--Lacking iron in sufficient percentage to have any dominating influence on properties of the materials

  I. Strength--The ability of a metal to withstand some kind of force without breaking down

  J. Tensile strength--The resistance of a material to a force that is acting to pull it apart

  K. Structure--The way in which the elements of an alloy, on the atoms of one element, are arranged

  L. Ductile--Refers to the ability of a material to become permanently deformed without failure

  M. Malleable--Refers to the ability to be shaped

  N. Weldability--Refers to the capacity of a metal to be fabricated by welding under improved conditions into a structure adequate for the intended purpose

II. Common metals that can be welded

  A. Steel

  B. Iron

INFORMATION SHEET

- C. Aluminum
- D. Copper
- E. Magnesium
- F. Alloys of the above

(NOTE: Most metals may be welded if the proper process and technique are used.)

III. Shapes of metals (Transparency 1)

- A. Structural and bar shapes
  - 1. H-beam
  - 2. I-beam
  - 3. Channels
  - 4. Angles
  - 5. T's
  - 6. Z's
- B. Sheets and strips
- C. Plates
- D. Hot rolled bars
  - 1. Rounds
  - 2. Ovals
  - 3. Half-ovals
  - 4. Squares
  - 5. Half-rounds
  - 6. Strips
  - 7. Flats
- E. Cold finished bars
  - 1. Rounds
  - 2. Shafting
  - 3. Hexagons

INFORMATION SHEET

    4. Squares

    5. Flats

  F. Tubings

    1. Round

    2. Square

    3. Rectangle

  G. Pipes

    1. Thin walled

    2. Thick walled

IV. Methods used for metal identification (Transparencies 2 and 3)

  A. Appearance--Observe condition of surface finish, color, and texture of bar stock

  B. Spark test--Observe color and type of sparks from the grinding wheel

  C. Manufacturer's stamp--Observe the SAE/AISI number on the end of bar stock

  D. Color code--Observe the manufacturer's individual color coding system for various types of metals

  E. Magnet reaction--Most non-ferrous will not show any attraction for magnet

  F. Filing the surface--Observe freshly filed surface for color and texture; this removes any oxide coating and exposes the true color of the base material

V. SAE/AISI number code for metals

(NOTE: For ASTM specifications, see Lincoln Electric publication M210.)

  A. Steel (Transparency 4)

    1. Society of Automotive Engineers(SAE)

    Example: SAE 10 20

      a. SAE--Society of Automotive Engineers

      b. 10--Low carbon steel with zero alloy

      c. 20--Percentage of carbon

INFORMATION SHEET

2. American Iron and Steel Institute (AISI)

   Example: AISI E 25 12

   a. AISI--American Iron and Steel Institute
   b. E--Electric furnace
   c. 2--Nickel
   d. 5--Percent of Ni alloy
   e. 12--Percent of carbon

B. Non-ferrous aluminums (Transparency 5)

1. Aluminum alloy-1030

   a. 1--First digit--Major alloying element
      1) 1--Aluminum
      2) 2--Copper
      3) 3--Manganese
      4) 4--Silicon
      5) 5--Magnesium
      6) 6--Magnesium and silicon
      7) 7--Zinc
      8) 8--Other
   b. 0--Second digit indicates purity limits
   c. 30--Last two digits indicate or identify aluminum alloy or impurities (99.30% minimum aluminum)

2. Aluminum copper alloy

   Example: 2024 T6 AQ

   a. 2--Copper
   b. 0--Purity limits
   c. 24--(99.24% aluminum alloy)

INFORMATION SHEET

d. T6--Solution heat treated, artificially aged

  1) F--As fabricated

  2) O--Annealed (wrought only)

  3) H--Strain hardened

    a) H_1--Strained hardened only

    b) H_2--Strained hardened; particularly annealed

    c) H_3--Strained hardened; stabilized

  4) W--Solutions heat treated; unstable temper

  5) T--More stable tempers than F, O, or H

    a) T_2--Annealed (cast only)

    b) T_3--Solution heat treated; cold worked

    c) T_4--Solution heat treated; naturally aged

    d) T_5--Artificially aged

    e) T_6--Solution heat treated; artificially aged

    f) T_7--Solution heat treated; stabilized

    g) T_8--Solution heat treated; cold worked; artificially aged

    h) T_9--Solution heat treated; artificially aged; cold worked

    i) T_{10}--Artificially aged; cold worked

e. AQ--Aircraft quality

  1) CR--Cold rolled

  2) CD--Cold drawn

  3) HR--Hot rolled

  4) AQ--Aircraft quality

  5) CQ--Commercial quality

INFORMATION SHEET

6) H--Hard*

7) HTQ--High tensile quality

8) AR--As rolled

9) HT--Heat treated

10) G--Grooved

(*NOTE: In indicating amount of hardness such as 1/4H, 1/2H, H, or other combinations, a base of 8 is used.)

Examples: 1/4H2/8; 1/2H4/8;
3/4H=6/8; H = 8/8

VI. Ferrous and non-ferrous metals

A. Ferrous--Dominated by iron

1. Steels
    a. Low carbon steels
    b. Medium carbon steels
    c. High carbon steels
    d. Alloy steels
    e. Low alloy, high tensile steels
2. Cast irons
    a. Gray cast
    b. Alloy cast
    c. White cast
    d. Malleable cast
    e. Nodular irons
3. Wrought irons
    a. Nickel wrought
    b. Unalloyed wrought

INFORMATION SHEET

4. Cast steels
    a. Carbon steel casting
    b. Low alloy steel casting
    c. Alloy steel casting
    d. Manganese steel casting
    e. Stainless steel casting
5. Stainless steels
    a. Group 1--Chromium-nickel studs
    b. Group 2--Hardenable chrominum
    c. Group 3--Non-hardenable steels
    d. Extra low carbon (ELC) stainless steels
6. Clad steels

B. Non-ferrous materials--Absence of iron
1. Copper and copper alloys
    a. Brass
    b. Bronzes
2. Aluminum and its alloys
    a. Wrought aluminum alloys
    b. Cast aluminum alloys
3. Magnesium and its alloys
4. Zinc and its alloys
5. Nickel and nickel alloys
6. Lead

VII. Basic types of carbon steels

A. Low carbon

(NOTE: Low carbon steel is used for chain, nails, pipe, rivets, screws, bars, or plates.)

INFORMATION SHEET

B. Medium carbon

(NOTE: Medium carbon steel is used for axles, connecting rods, or shafting.)

C. High carbon

(NOTE: High carbon steel is used for crankshafts, scraper blades, automobile springs, or anvils.)

D. Very high carbon

(NOTE: Very high carbon steel is used for chisel, punches, knives, lathe tools, files, or metal cutting saws.)

VIII. Importance of metallurgy

A. Provides employment for many people

B. Meets the needs of those dependent on metals

C. Requires the correct selection of metal for each job

D. Provides a selection of metals in various shapes and forms

E. Improves welding through metallurgical research

IX. Difference between low alloy, high tensile steels and low carbon steels

A. Low alloy, high tensile steels

1. Low carbon content
2. Small content of alloying elements
3. High yield strength and ductile
4. Higher priced
5. Can use thinner sections
6. Resistant to corrosion
7. High impact and endurance
8. Ease of forming
9. Good weldability

INFORMATION SHEET

B. Low carbon steels

(NOTE: Low carbon steel is commonly referred to as mild steel.)

1. Tough
2. Ductile
3. Easily formed
4. Machineable
5. Excellent weldability
6. Wide variety of uses

X. Properties of metals

A. Mechanical

1. Compression strength
2. Tensile strength
3. Hardness
4. Ductility
5. Brittleness

(NOTE: All the above properties can be measured by a mechanical test.)

B. Physical

1. Density
2. Resistant to corrosion
3. Electrical and thermal conductivity
4. Thermal expansion

(NOTE: These properties do not relate to an applied force of some kind.)

XI. Advantages of using aluminum

A. Earth's most abundant metal

(NOTE: Aluminum constitutes about eight percent of earth's crust.)

INFORMATION SHEET

B. Excellent strength in comparison to weight

C. Generally highly resistant to most forms of corrosion

D. Very attractive appearance

E. Very ductile and malleable

F. Reasonably inexpensive

XII. Major condition causing aluminum to be considered difficult to weld

A. Very active metal (chemically)

B. Oxidizes easily at room temperatures

(NOTE: Oxide coating melts at 3600° whereas metal melts at 1215°.)

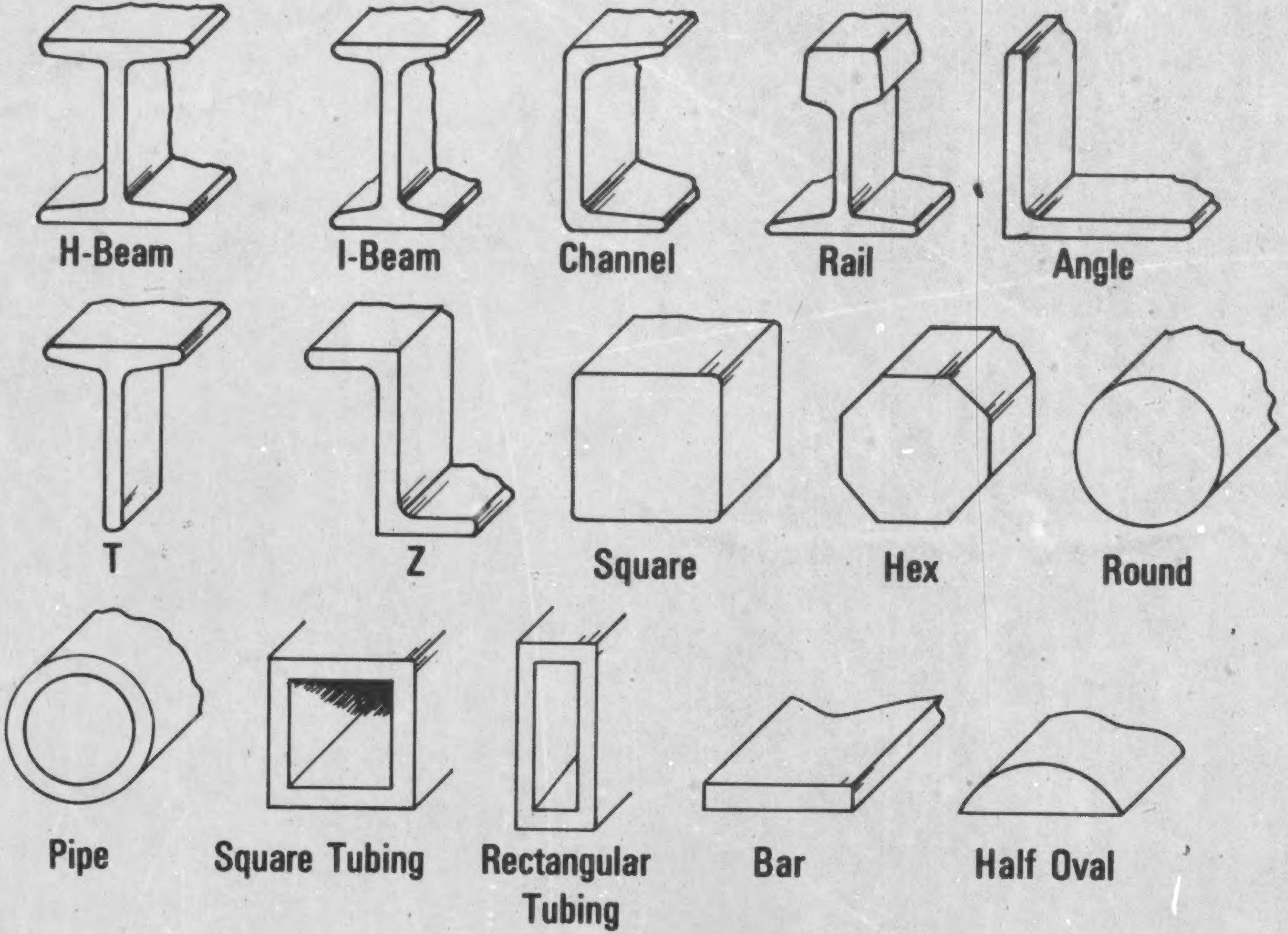
C. Does not change color when it approaches the melting point

D. Dissipates heat five times faster than steel

E. Requires support (back-up bars) on thin sections to prevent sagging weld joint

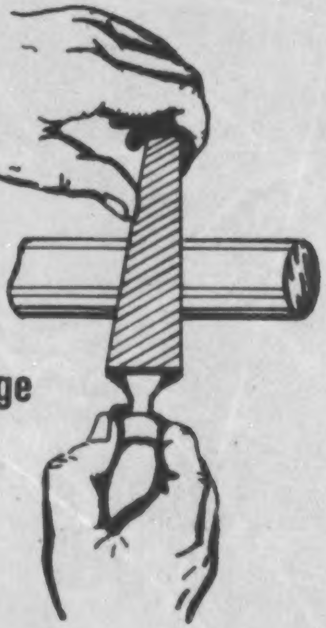
F. Requires thorough cleaning previous to welding

Shapes of Metals

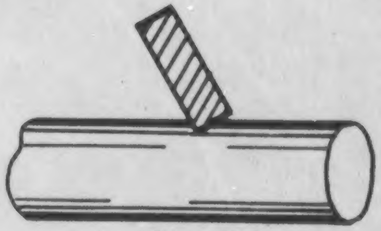

H-Beam
I-Beam
Channel
Rail
Angle
T
Z
Square
Hex
Round
Pipe
Square Tubing
Rectangular Tubing
Bar
Half Oval

Methods of Identifying Metals

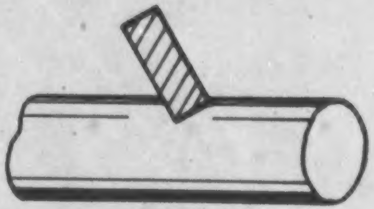
FILE TEST



File
on Edge



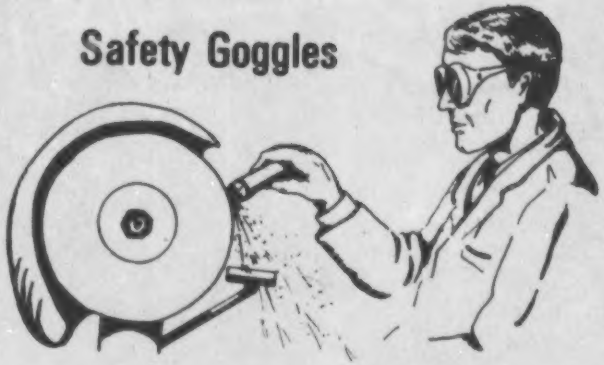
Hard



Soft

SPARK TEST

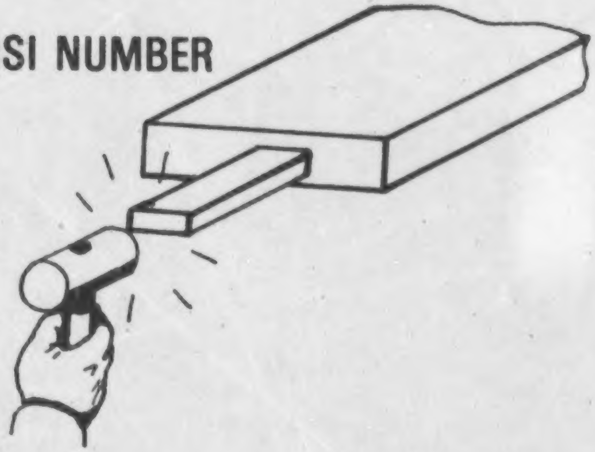
Safety Goggles



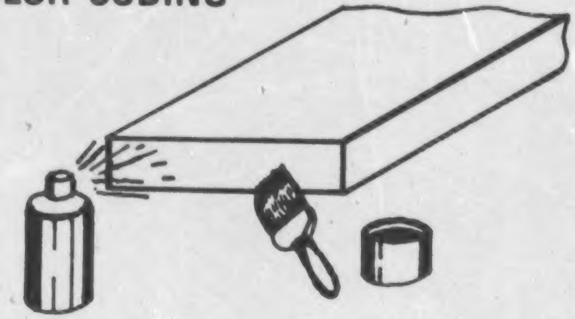
Methods of Identifying Metals

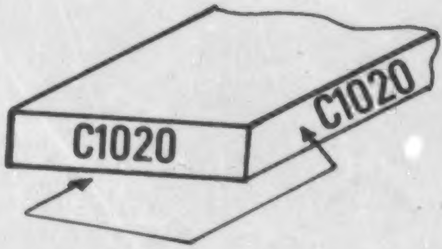
(CONTINUED)

STAMP SAE/AISI NUMBER



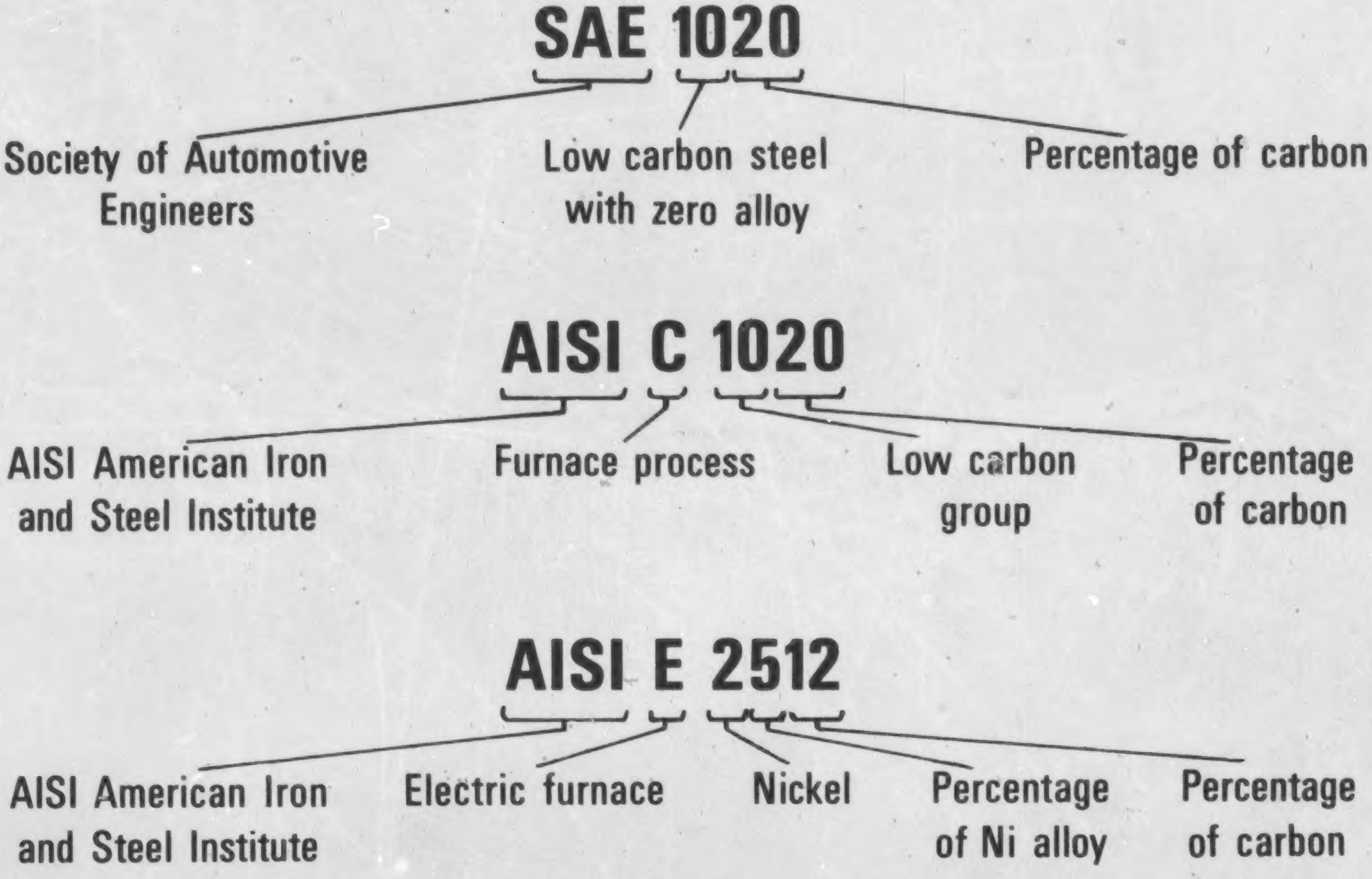
COLOR CODING


Spray
Brush


C1020
C1020

SAE/AISI Number

SAE/AISI Designations



SAE 1020

Society of Automotive Engineers

Low carbon steel with zero alloy

Percentage of carbon

AISI C 1020

AISI American Iron and Steel Institute

Furnace process

Low carbon group

Percentage of carbon

AISI E 2512

AISI American Iron and Steel Institute

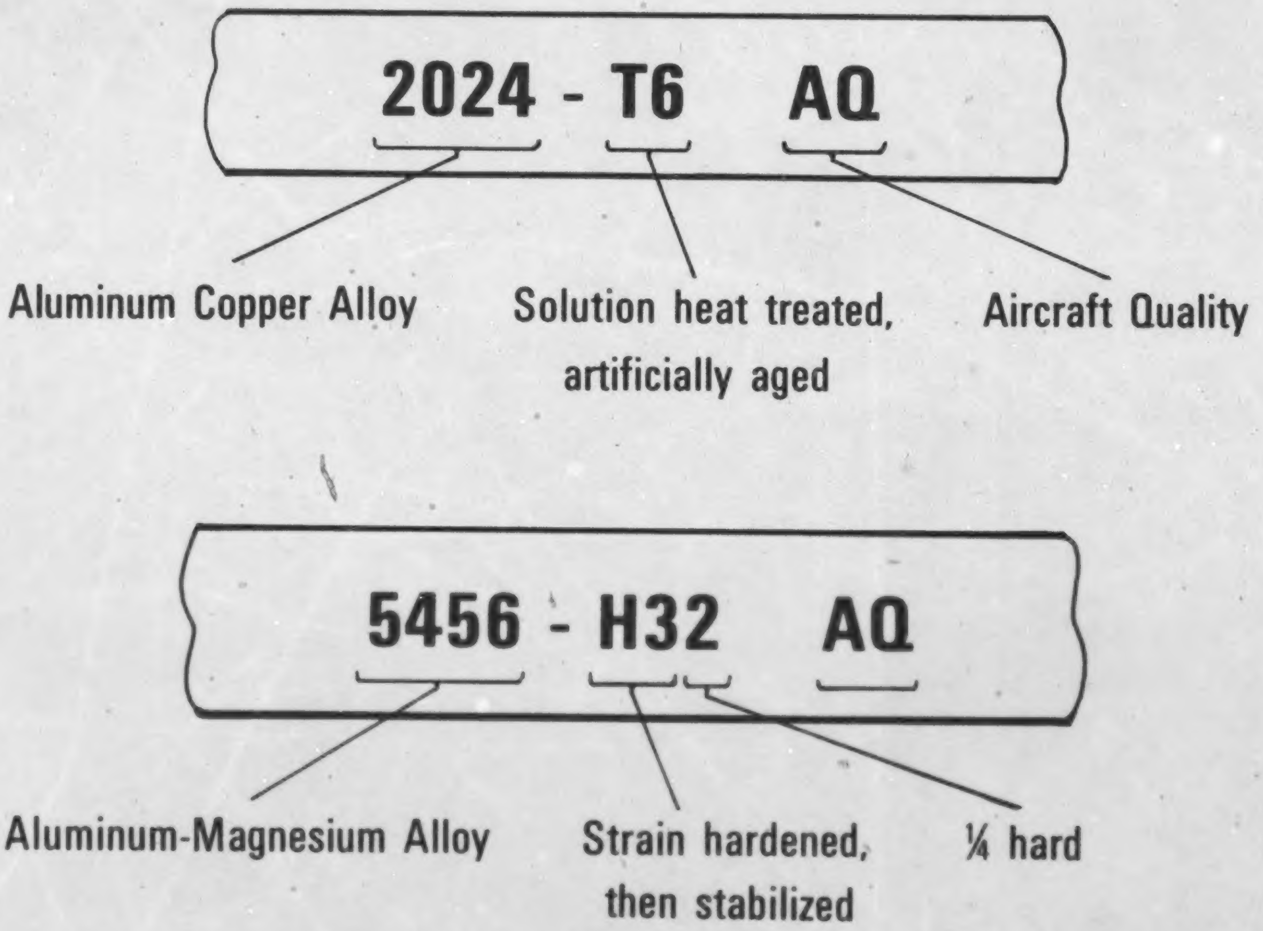
Electric furnace

Nickel

Percentage of Ni alloy

Percentage of carbon

Identification Markings



2024 - T6 AQ

Aluminum Copper Alloy

Solution heat treated, artificially aged

Aircraft Quality

5456 - H32 AQ

Aluminum-Magnesium Alloy

Strain hardened, then stabilized

¼ hard

METALS
UNIT III

ASSIGNMENT SHEET #1--WRITE A METAL ANALYSIS

Using the enclosed charts, complete the metal analysis. Locate the SAE number in left hand column, then locate and list the AISI number in the adjacent right hand column. This number designates the type of furnace by which the metal was processed. Then locate and list the carbon percentage in the third adjacent right hand column to the SAE number. Locate and list the TYPE of metal by noting the major chart heading above the various portions of the chart such as FREECUTTING, CARBON STEELS, NICKEL STEELS, or other headings.

Use the exercise sheet to list the required elements given for each steel.

Keep exercise sheet neat and easy to read. Hand in to the instructor for evaluation.

Examples:

(Column Headings)

SAE No.	AISI No.	Percent Carbon	Type of Metal
1030	C1030	0.28/0.34	Carbon Steel
3310	E3310	0.08/0.13	Nickel-Chromium Steel
4037	4037	0.35/0.40	Molybdenum Steel

Find the percentages of the following steels. List the AISI number designation and type of steel.

1. 1010
2. 1040
3. 1095
4. 1112
5. 1113
6. 2340
7. 4140
8. 5120
9. 9315
10. 6150

ASSIGNMENT SHEET #1

No	SAE No.	AISI No.	Percent Carbon	Type of Metal
1.				
2.				
3.				
4.				
5.				

6.				
7.				
8.				
9.				
10.				

ASSIGNMENT SHEET #1

CARBON STEELS*

SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT				SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT			
		CARBON	MANGANESE	PHOSPHORUS	SULFUR			CARBON	MANGANESE	PHOSPHORUS	SULFUR
1008	C 1008	0.10 max	0.25/0.50	0.040	0.050	1041	C 1041	0.36/0.44	1.35/1.65	0.040	0.050
1010	C 1010	0.08/0.13	0.30/0.60	0.040	0.050	1042	C 1042	0.40/0.47	0.60/0.90	0.040	0.050
	C 1012	0.10/0.15	0.30/0.60	0.040	0.050	1043	C 1043	0.40/0.47	0.70/1.00	0.040	0.050
1015	C 1015	0.13/0.18	0.30/0.60	0.040	0.050	1045	C 1045	0.43/0.50	0.60/0.90	0.040	0.050
1016	C 1016	0.13/0.18	0.60/0.90	0.040	0.050	1046	C 1046	0.43/0.50	0.70/1.00	0.040	0.050
1017	C 1017	0.15/0.20	0.30/0.60	0.040	0.050		C 1049	0.46/0.53	0.60/0.90	0.040	0.050
1018	C 1018	0.15/0.20	0.60/0.90	0.040	0.050	1050	C 1050	0.48/0.55	0.60/0.90	0.040	0.050
1019	C 1019	0.15/0.20	0.70/1.00	0.040	0.050	1052	C 1052	0.47/0.55	1.20/1.50	0.040	0.050
1020	C 1020	0.18/0.23	0.30/0.60	0.040	0.050		C 1053	0.48/0.55	0.70/1.00	0.040	0.050
	C 1021	0.18/0.23	0.60/0.90	0.040	0.050	1055	C 1055	0.50/0.60	0.60/0.90	0.040	0.050
1022	C 1022	0.18/0.23	0.70/1.00	0.040	0.050	1060	C 1060	0.55/0.65	0.60/0.90	0.040	0.050
	C 1023	0.20/0.25	0.30/0.60	0.040	0.050	1065	C 1065	0.60/0.70	0.60/0.90	0.040	0.050
1024	C 1024	0.19/0.25	1.35/1.65	0.040	0.050		C 1069	0.65/0.75	0.40/0.70	0.040	0.050
1025	C 1025	0.22/0.28	0.30/0.60	0.040	0.050	1070	C 1070	0.65/0.75	0.60/0.90	0.040	0.050
	C 1026	0.22/0.28	0.60/0.90	0.040	0.050		C 1072	0.65/0.76	1.00/1.30	0.040	0.050
1027	C 1027	0.22/0.29	1.20/1.50	0.040	0.050		C 1075	0.70/0.80	0.40/0.70	0.040	0.050
	C 1029	0.25/0.31	0.60/0.90	0.040	0.050	1078	C 1078	0.72/0.85	0.30/0.60	0.040	0.050
1030	C 1030	0.28/0.34	0.60/0.90	0.040	0.050	1080	C 1080	0.75/0.88	0.60/0.90	0.040	0.050
1033	C 1033	0.30/0.36	0.70/1.00	0.040	0.050		C 1084	0.80/0.93	0.60/0.90	0.040	0.050
1035	C 1035	0.32/0.38	0.60/0.90	0.040	0.050	1085	C 1085	0.80/0.93	0.70/1.00	0.040	0.050
1036	C 1036	0.30/0.37	1.20/1.50	0.040	0.050		C 1086	0.82/0.96	0.30/0.50	0.040	0.050
	C 1037	0.35/0.42	0.40/0.70	0.040	0.050	1090	C 1090	0.85/0.98	0.60/0.90	0.040	0.050
1038	C 1038	0.35/0.42	0.60/0.90	0.040	0.050	1095	C 1095	0.90/1.03	0.30/0.50	0.040	0.050
	C 1039	0.37/0.44	0.70/1.00	0.040	0.050		B 1010	0.13 max	0.30/0.60	0.07/0.12	0.060
1040	C 1040	0.37/0.44	0.60/0.90	0.040	0.050						
FREE-CUTTING STEELS (OPEN-HEARTH SCREW STEELS)											
	C 1108	0.08/0.13	0.50/0.80	0.040	0.07/0.12		C 1132	0.27/0.34	1.35/1.65	0.040	0.08/0.13
1109	C 1109	0.08/0.13	0.60/0.90	0.040	0.08/0.13	1137	C 1137	0.32/0.39	1.35/1.65	0.040	0.08/0.13
	C 1110	0.08/0.13	0.30/0.60	0.040	0.08/0.13	1138	C 1138	0.34/0.40	0.70/1.00	0.040	0.08/0.13
	C 1118	0.10/0.16	1.00/1.30	0.040	0.24/0.33	1140	C 1140	0.37/0.44	0.70/1.00	0.040	0.08/0.13
1115	C 1115	0.13/0.18	0.60/0.90	0.040	0.08/0.13	1141	C 1141	0.37/0.45	1.35/1.65	0.040	0.08/0.13
1116	C 1116	0.14/0.20	1.10/1.40	0.040	0.16/0.23	1144	C 1144	0.40/0.48	1.35/1.65	0.040	0.24/0.33
1117	C 1117	0.14/0.20	1.00/1.30	0.040	0.08/0.13	1145	C 1145	0.42/0.49	0.70/1.00	0.040	0.04/0.07
1118	C 1118	0.14/0.20	1.30/1.60	0.040	0.08/0.13	1146	C 1146	0.42/0.49	0.70/1.00	0.040	0.08/0.13
1119	C 1119	0.14/0.20	1.00/1.30	0.040	0.24/0.33		C 1148	0.45/0.52	0.70/1.00	0.040	0.04/0.07
1120	C 1120	0.18/0.23	0.70/1.00	0.040	0.08/0.13	1151	C 1151	0.48/0.55	0.70/1.00	0.040	0.08/0.13
	C 1125	0.22/0.28	0.60/0.90	0.040	0.08/0.13						
FREE-CUTTING STEELS (BESSEMER SCREW STEELS)											
1111	B 1111	0.13 max	0.60/0.90	0.07/0.12	0.08/0.15	1113	B 1113	0.13 max	0.70/1.00	0.07/0.12	0.24/0.33
1112	B 1112	0.13 max	0.70/1.00	0.07/1.00	0.16/0.23						

*From combined standard steel lists of American Iron and Steel Institute and Society of Automotive Engineers, Inc.

ASSIGNMENT SHEET #1

COMBINED STANDARD STEEL TABLE*

SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT								
		CARBON	MANGANESE	PHOSPHORUS MAX	SULFUR MAX	SILICON	NICKEL	CHROMIUM	MOLYBDENUM	VANADIUM
MANGANESE STEELS (MANGANESE IN ALLOY RANGE)										
1320	1320	0.18/0.23	1.60/1.90	0.040	0.040	0.20/0.35				
	1321	0.17/0.22	1.80/2.10	0.050	0.050	0.20/0.35				
1330	1330	0.28/0.33	1.60/1.90	0.040	0.040	0.20/0.35				
1335	1335	0.33/0.38	1.60/1.90	0.040	0.040	0.20/0.35				
1340	1340	0.38/0.43	1.60/1.90	0.040	0.040	0.20/0.35				
NICKEL STEELS										
2317	2317	0.15/0.20	0.40/0.60	0.040	0.040	0.20/0.35	3.25/3.75			
2330	2330	0.28/0.33	0.60/0.80	0.040	0.040	0.20/0.35	3.25/3.75			
	2335	0.33/0.38	0.60/0.80	0.040	0.040	0.20/0.35	3.25/3.75			
2340	2340	0.38/0.43	0.70/0.90	0.040	0.040	0.20/0.35	3.25/3.75			
2345	2345	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35	3.25/3.75			
2512	E 2512	0.09/0.14	0.45/0.60	0.025	0.025	0.20/0.35	4.75/5.25			
2515	2515	0.12/0.17	0.40/0.60	0.040	0.040	0.20/0.35	4.75/5.25			
2517	E 2517	0.15/0.20	0.45/0.60	0.025	0.025	0.20/0.35	4.75/5.25			
NICKEL-CHROMIUM STEELS										
3115	3115	0.13/0.18	0.40/0.60	0.040	0.040	0.20/0.35	1.10/1.40	0.55/0.75		
3120	3120	0.17/0.22	0.60/0.80	0.040	0.040	0.20/0.35	1.10/1.40	0.55/0.75		
3130	3130	0.28/0.33	0.60/0.80	0.040	0.040	0.20/0.35	1.10/1.40	0.55/0.75		
3135	3135	0.33/0.38	0.60/0.80	0.040	0.040	0.20/0.35	1.10/1.40	0.55/0.75		
3140	3140	0.38/0.43	0.70/0.90	0.040	0.040	0.20/0.35	1.10/1.40	0.55/0.75		
3141	3141	0.38/0.43	0.70/0.90	0.040	0.040	0.20/0.35	1.10/1.40	0.70/0.90		
3145	3145	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35	1.10/1.40	0.70/0.90		
3150	3150	0.48/0.53	0.70/0.90	0.040	0.040	0.20/0.35	1.10/1.40	0.70/0.90		
3310	E 3310	0.08/0.13	0.45/0.60	0.025	0.025	0.20/0.35	3.25/3.75	1.40/1.75		
3316	E 3316	0.14/0.19	0.45/0.60	0.025	0.025	0.20/0.35	3.25/3.75	1.40/1.75		
MOLYBDENUM STEELS										
4017	4017	0.15/0.20	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4023	4023	0.20/0.25	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4024	4024	0.20/0.25	0.70/0.90	0.040	0.035/0.050	0.20/0.35			0.20/0.30	
4027	4027	0.25/0.30	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4028	4028	0.25/0.30	0.70/0.90	0.040	0.035/0.050	0.20/0.35			0.20/0.30	
4032	4032	0.30/0.35	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	

*From combined standard steel lists of American Iron and Steel Institute and Society of Automotive Engineers, Inc.

ASSIGNMENT SHEET #1

COMBINED STANDARD STEEL TABLE (continued)

SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT								
		CARBON	MANGANESE	PHOSPHORUS MAX	SULFUR MAX	SILICON	NICKEL	CHROMIUM	MOLYBDENUM	VANADIUM
		MOLYBDENUM STEELS — CONTINUED								
4037	4037	0.35/0.40	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4042	4042	0.40/0.45	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4047	4047	0.45/0.50	0.70/0.90	0.040	0.040	0.20/0.35			0.20/0.30	
4053	4053	0.50/0.56	0.75/1.00	0.040	0.040	0.20/0.35			0.20/0.30	
4063	4063	0.60/0.67	0.75/1.00	0.040	0.040	0.20/0.35			0.20/0.30	
4068	4068	0.63/0.70	0.75/1.00	0.040	0.040	0.20/0.35			0.20/0.30	
4130	4130	0.28/0.33	0.40/0.60	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
	E 4132	0.30/0.35	0.40/0.60	0.025	0.025	0.20/0.35		0.80/1.10	0.18/0.25	
	E 4135	0.33/0.38	0.70/0.90	0.025	0.025	0.20/0.35		0.80/1.10	0.18/0.25	
4137	4137	0.35/0.40	0.70/0.90	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
	E 4137	0.35/0.40	0.70/0.90	0.025	0.025	0.20/0.35		0.80/1.10	0.18/0.25	
4140	4140	0.38/0.43	0.75/1.00	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
	4142	0.40/0.45	0.75/1.00	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
4145	4145	0.43/0.48	0.75/1.00	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
	4147	0.45/0.50	0.75/1.00	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
4150	4150	0.48/0.53	0.75/1.00	0.040	0.040	0.20/0.35		0.80/1.10	0.15/0.25	
4317	4317	0.15/0.20	0.45/0.65	0.040	0.040	0.20/0.35	1.65/2.00	0.40/0.60	0.20/0.30	
4320	4320	0.17/0.22	0.45/0.65	0.040	0.040	0.20/0.35	1.65/2.00	0.40/0.60	0.20/0.30	
	4337	0.35/0.40	0.60/0.80	0.040	0.040	0.20/0.35	1.65/2.00	0.70/0.90	0.20/0.30	
4340	4340	0.38/0.43	0.60/0.80	0.040	0.040	0.20/0.35	1.65/2.00	0.70/0.90	0.20/0.30	
4608	4608	0.06/0.11	0.25/0.45	0.040	0.040	0.25 max	1.40/1.75		0.15/0.25	
4615	4615	0.13/0.18	0.45/0.65	0.040	0.040	0.20/0.35	1.65/2.00		0.20/0.30	
4617	E 4617	0.15/0.20	0.45/0.65	0.025	0.025	0.20/0.35	1.65/2.00		0.20/0.27	
4620	4620	0.17/0.22	0.45/0.65	0.040	0.040	0.20/0.35	1.65/2.00		0.20/0.30	
X 4620	X 4620	0.18/0.23	0.50/0.70	0.040	0.040	0.20/0.35	1.65/2.00		0.20/0.30	
	E 4620	0.17/0.22	0.45/0.65	0.025	0.025	0.20/0.35	1.65/2.00		0.20/0.27	
4621	4621	0.18/0.23	0.70/0.90	0.040	0.040	0.20/0.35	1.65/2.00		0.20/0.30	
4640	4640	0.38/0.43	0.60/0.80	0.040	0.040	0.20/0.35	1.65/2.00		0.20/0.30	
	E 4640	0.38/0.43	0.60/0.80	0.025	0.025	0.20/0.35	1.65/2.00	....	0.20/0.27	
4812	4812	0.10/0.15	0.40/0.60	0.040	0.040	0.20/0.35	3.25/3.75		0.20/0.30	
4815	4815	0.13/0.18	0.40/0.60	0.040	0.040	0.20/0.35	3.25/3.75		0.20/0.30	
4817	4817	0.15/0.20	0.40/0.60	0.040	0.040	0.20/0.35	3.25/3.75		0.20/0.30	
4820	4820	0.18/0.23	0.50/0.70	0.040	0.040	0.20/0.35	3.25/3.75		0.20/0.30	

ASSIGNMENT SHEET #1

COMBINED STANDARD STEEL TABLE (continued)

SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT								
		CARBON	MANGANESE	PHOSPHORUS MAX	SULFUR MAX	SILICON	NICKEL	CHROMIUM	MOLYBDENUM	VANADIUM
					CHROMIUM STEELS					
5045	5045	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35		0.55/0.75		
5046	5046	0.43/0.50	0.75/1.00	0.040	0.040	0.20/0.35		0.20/0.35		
5120	5120	0.17/0.22	0.70/0.90	0.040	0.040	0.20/0.35		0.70/0.90		
5130	5130	0.28/0.33	0.70/0.90	0.040	0.040	0.20/0.35		0.80/1.10		
5132	5132	0.30/0.35	0.60/0.80	0.040	0.040	0.20/0.35		0.75/1.00		
5135	5135	0.33/0.38	0.60/0.80	0.040	0.040	0.20/0.35		0.80/1.05		
5140	5140	0.38/0.43	0.70/0.90	0.040	0.040	0.20/0.35		0.70/0.90		
5145	5145	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35		0.70/0.50		
5147	5147	0.45/0.52	0.70/0.95	0.040	0.040	0.20/0.35		0.85/1.15		
5150	5150	0.48/0.53	0.70/0.90	0.040	0.040	0.20/0.35		0.70/0.90		
5152	5152	0.48/0.55	0.70/0.90	0.040	0.040	0.20/0.35		0.90/1.20		
	5160	0.55/0.65	0.75/1.00	0.040	0.040	0.20/0.35		0.70/0.90		
50100	E 50100	0.95/1.10	0.25/0.45	0.025	0.025	0.20/0.35		0.40/0.60		
51100	E 51100	0.95/1.10	0.25/0.45	0.025	0.025	0.20/0.35		0.90/1.15		
52100	E 52100	0.95/1.10	0.25/0.45	0.025	0.025	0.20/0.35		1.30/1.60		
					CHROMIUM-VANDIUM STEELS					
	6120	0.17/0.22	0.70/0.90	0.040	0.040	0.20/0.35		0.70/0.90		0.10 min.
	6145	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35		0.80/1.10		0.15 min.
6150	6150	0.48/0.53	0.70/0.90	0.040	0.040	0.20/0.35		0.80/1.10		0.15 min.
	6152	0.48/0.55	0.70/0.90	0.040	0.040	0.20/0.35		0.80/1.10		0.10 min.
					NICKEL-CHROMIUM-MOLYBDENUM STEELS					
8615	8615	0.13/0.18	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8617	8617	0.15/0.20	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8620	8620	0.18/0.23	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8622	8622	0.20/0.25	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8625	8625	0.23/0.28	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8627	8627	0.25/0.30	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8630	8630	0.28/0.33	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8632	8632	0.30/0.35	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.80	0.15/0.25	
8635	8635	0.33/0.38	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8637	8637	0.35/0.40	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8640	8640	0.38/0.43	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8641	8641	0.38/0.43	0.75/1.00	0.040	0.040/0.060	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	

ASSIGNMENT SHEET #1

COMBINED STANDARD STEEL TABLE (continued)

SAE NUMBER	1948 AISI NUMBER	CHEMICAL COMPOSITION LIMITS, PERCENT								
		CARBON	MANGANESE	PHOSPHORUS MAX	SULFUR MAX	SILICON	NICKEL	CHROMIUM	MOLYBDENUM	VANADIUM
NICKEL-CHROMIUM-MOLYBDENUM STEELS—CONTINUED										
8642	8642	0.40/0.45	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8645	8645	0.43/0.48	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8647	8647	0.45/0.50	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8650	8650	0.48/0.53	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.70	0.15/0.25	
8653	8653	0.50/0.56	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.50/0.80	0.15/0.25	
8655	8655	0.50/0.60	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
8660	8660	0.55/0.65	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.15/0.25	
	8715	0.18/0.23	0.60/0.80	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
8720	8720	0.18/0.23	0.70/0.90	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
8735	8735	0.33/0.38	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
8740	8740	0.38/0.43	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
	8742	0.40/0.45	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
8745	8745	0.43/0.48	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
	8747	0.45/0.50	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
8750	8750	0.48/0.53	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.20/0.30	
9255	9255	0.50/0.60	0.70/0.95	0.040	0.040	1.80/2.20				
9260	9260	0.55/0.65	0.70/1.00	0.040	0.040	1.80/2.20				
9261	9261	0.55/0.65	0.75/1.00	0.040	0.040	1.80/2.20		0.10/0.25		
9262	9262	0.55/0.65	0.75/1.00	0.040	0.040	1.80/2.20		0.25/0.40		
9310	E 9310	0.08/0.13	0.45/0.65	0.025	0.025	0.20/0.35	3.00/3.50	1.00/1.40	0.08/0.15	
9315	E 9315	0.13/0.18	0.45/0.65	0.025	0.025	0.20/0.35	3.00/3.50	1.00/1.40	0.08/0.15	
9317	E 9317	0.15/0.20	0.45/0.65	0.025	0.025	0.20/0.35	3.00/3.50	1.00/1.40	0.08/0.15	
9437	9437	0.35/0.40	0.90/1.20	0.040	0.040	0.20/0.35	0.30/0.60	0.30/0.50	0.08/0.15	
9440	9440	0.38/0.43	0.90/1.20	0.040	0.040	0.20/0.35	0.30/0.60	0.30/0.50	0.08/0.15	
9442	9442	0.40/0.45	1.00/1.30	0.040	0.040	0.20/0.35	0.30/0.60	0.30/0.50	0.08/0.15	
9445	9445	0.43/0.48	1.00/1.30	0.040	0.040	0.20/0.35	0.30/0.60	0.30/0.50	0.08/0.15	
9747	9747	0.45/0.50	0.50/0.80	0.040	0.040	0.20/0.35	0.40/0.70	0.10/0.25	0.15/0.25	
9763	9763	0.60/0.67	0.50/0.80	0.040	0.040	0.20/0.35	0.40/0.70	0.10/0.25	0.15/0.25	
9840	9840	0.38/0.43	0.70/0.90	0.040	0.040	0.20/0.35	0.85/1.15	0.70/0.90	0.20/0.30	
9845	9845	0.43/0.48	0.70/0.90	0.040	0.040	0.20/0.35	0.85/1.15	0.70/0.90	0.20/0.30	
9850	9850	0.48/0.53	0.70/0.90	0.040	0.040	1.20/0.35	0.85/1.15	0.70/0.90	0.20/0.30	

ASSIGNMENT SHEET #1

Rapid Identification of Metals

Metal	Surface Appearance or markings	Reaction to a Magnet	Color of freshly filed surface
White cast iron	Dull gray	Strong	Silvery white
Gray cast iron	Dull gray	Strong	Light silvery gray
Aluminum	Light gray to white dull or brilliant	None	White
Brass	Yellow to green or brown	None	Reddish yellow to yellowish white
Bronze	Red to brown	None	Reddish yellow to yellowish white
Copper	Smooth; red brown to green (oxides)	None	Bright copper color
Copper-nickel	Smooth; gray to yellow or yellowish green	None	Bright silvery white
Lead	White to gray; smooth, velvety	None	White
Nickel	Dark gray; smooth; sometimes green (oxides)	Medium	Bright silvery white
Nickel-copper	Dark gray, smooth	Very slight	Light gray
Plain carbon steel	Dark gray; may be rusty	Strong	Bright silvery gray
Stainless steel (18-8) (25-20) "Note 1 below"	Dark gray; dull to brilliant; usually clean	None (faint if severely cold worked)	Bright silvery gray
Zinc	Whitish blue, may be mottled	None	White

1. Stainless steels that have less than 26 percent alloying elements react to magnet.

FERROUS AND FERROUS ALLOYS
UNIT III

ANSWERS TO ASSIGNMENT SHEET #1

NO.	SAE NO.	AISI NO.	CHEM. COMP. % CARBON	TYPE
1.	1010	C1010	0.08/0.13	Carbon Steel
2.	040	C1040	0.37/0.44	Carbon Steel
3.	1095	C1095	0.90/1.03	Carbon Steel
4.	1112	B1112	0.13 max.	Free-cutting
5.	1113	B1113	0.13 max.	Free-cutting
6.	2340	2340	0.38/0.43	Nickel Steel
7.	4140	4140	0.38/0.43	Molybdenum Steel
8.	5120	5120	0.17/0.22	Chromium Steel
9.	9315	E9315	0.13/0.18	Nickel-Chromium-Vanadium Steel
10.	6150	6150	0.48/0.53	Chrome-Vanadium Steel

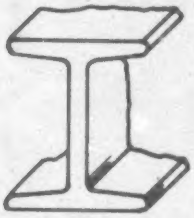
METALS
UNIT III

TEST

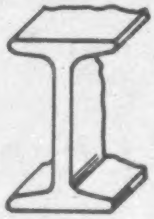
1. Define six terms associated with metals.
   - a. Metal--
   - b. Metallurgy--
   - c. Ore--
   - d. Ferrous--
   - e. Ductile--
   - f. Weldability--

2. List common metals that can be welded.
   - a.
   - b.
   - c.
   - d.
   - e.

3. Identify shapes of metals from the following drawings.



a.____________



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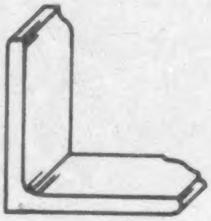

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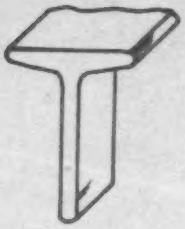
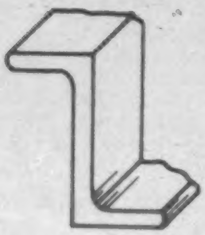
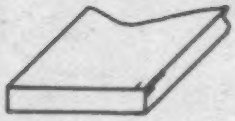


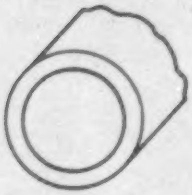
d. ____________



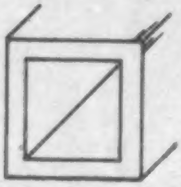
e. ____________



f. ____________



g. ____________



h. ____________

4. List four methods used for metal identification.

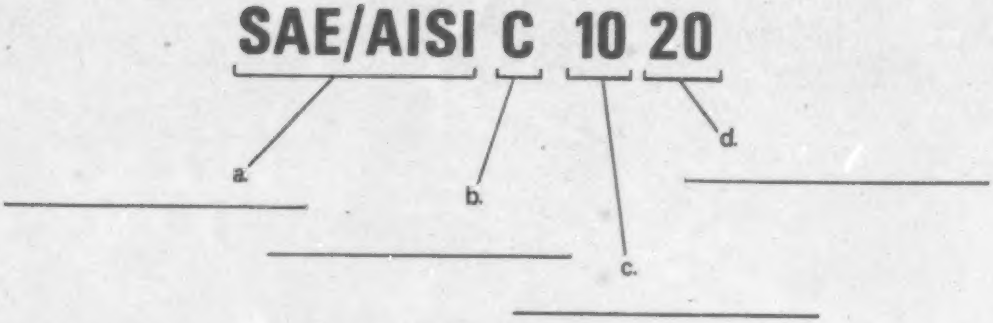
a.

b.

c.

d.

5. Identify the parts of the SAE/AISI numbering system for metals on the code given below.


SAE/AISI C 10 20
a.
b.
c.
d.

6. Classify metal as to ferrous or non-ferrous metals by placing a "F" in front of ferrous and "N" in front of non-ferrous.

______a. Low carbon steels

______b. Alloy cast

______c. Malleable cast

______d. Brass

______e. Low alloy, high tensile steel

______f. Bronze

______g. Nickel wrought

______h. Aluminum

______i. Low alloy steel castings

______j. Zinc

______k. Nickel

______l. Clad steels

7. List the four basic types of carbon steels.

a.

b.

c.

d.

8. Discuss in a short paragraph the importance of metallurgy.

9. Describe the difference between low alloy, high tensile steels and low carbon steels.

10. Discuss the properties of metals.

11. List five advantages of using aluminum in welding.

   a.

   b.

   c.

   d.

   e.

12. Discuss the major conditions that cause aluminum to be considered difficult to weld.

13. Write a metal analysis from given tables.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activity should be completed.)

METALS
UNIT III

ANSWERS TO TEST

1. a. Metal--An element that has all or most of the following characteristics: solid at room temperature; opaque; conductor of heat and electricity; reflective when polished; expands when heated and contracts when cooled

   b. Metallurgy--The science and technology of extracting metals from ores, refining them, and preparing them for use

   c. Ore--The rock or earth in which we find metals in their natural form

   d. Ferrous--Dominated by iron (Fe) in its chemical composition

   e. Ductile--Refers to the ability of a material to become permanently deformed without failure

   f. Weldability--Refers to the capacity of a metal to be fabricated by welding under improved conditions into a structure adequate for the intended purpose

2. Any five of the following

   a. Steel

   b. Iron

   c. Aluminum

   d. Copper

   e. Magnesium

   f. Alloys of the above

3. a. H-beam

   b. I-beam

   c. Angle

   d. T's

   e. Z's

   f. Solid square bar

   g. Pipe or tubing

   h. Square tubing

4. Any four of the following
   - a. Appearance
   - b. Spark test
   - c. Manufacturer's stamp
   - d. Color code
   - e. Magnet reaction
   - f. Filing the surface
5. a. SAE/AISI Society of Automobile Engineer/American Iron and Steel Institute
   - b. Furnace process
   - c. Low carbon group; no alloy
   - d. Percentage of carbon--20%
6. a. F
   - b. F
   - c. F
   - d. N
   - e. F
   - f. N
   - g. F
   - h. N
   - i. F
   - j. N
   - k. N
   - l. F
7. a. Low carbon
   - b. Medium carbon
   - c. High carbon
   - d. Very high carbon

8. Discussion should include:
    a. Provides employment for many people
    b. Meets the needs of those dependent on metals
    c. Requires the correct selection of metal for each job
    d. Provides a selection of metals in various shapes and forms
    e. Improves welding through metallurgical research
9. Description should include:
    a. Low alloy, high tensile steels
        1) High yield strength and ductile
        2) Small content of alloying elements
        3) Higher priced
        4) Can use thinner sections
        5) Resistant to corrosion
        6) High impact and endurance
        7) Ease of forming
        8) Good weldability
        9) Low carbon content
    b. Low carbon
        1) Tough
        2) Ductile
        3) Easily formed
        4) Machineable
        5) Excellent weldability
        6) Wide variety of uses
10. Discussion should include:
    a. Mechanical properties
        1) Compression strength
        2) Tensile strength

        3) Hardness
        4) Ductility
        5) Brittleness
    b. Physical
        1) Density
        2) Resistant to corrosion
        3) Electrical and thermal conductivity
        4) Thermal expansion

11. Any five of the following
    a. Earth's most abundant metal
    b. Excellent strength in comparison to weight
    c. Generally highly resistant to most forms of corrosion
    d. Very attractive appearance
    e. Very ductile and malleable
    f. Reasonably inexpensive

12. Discussion should include:
    a. Very active metal (chemically)
    b. Oxidizes easily at room temperature
    c. Does not change color when it approaches the melting point
    d. Dissipates heat five times faster than steel
    e. Requires support (back-up bars) on thin sections to prevent sagging weld joint
    f. Requires thorough cleaning previous to welding

13. Evaluated to the satisfaction of the instructor.

VICA
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name the purposes of the VICA organization. He should be able to write the VICA motto and VICA pledge from memory. He should be able to identify the symbols of the VICA emblem and tell what each represents. He should be able to write what each color of the VICA organization represents and the emphasis of the VICA creed. This knowledge will be evidenced by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Name five purposes of the VICA organization.
2. Write from memory the VICA motto.
3. Write from memory the VICA pledge.
4. Name four beliefs the VICA creed emphasizes.
5. Write what each color of the VICA organization represents.
6. Identify the symbols of the VICA emblem and write what each symbol represents.

VICA
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheet.

  C. Make transparency.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency master: TM 1--Symbols of the VICA Emblem

  D. Test

  E. Answers to test

II. Reference: *Official Guide.* Washington, D.C.: Vocational Industrial Clubs of America, Vocational Industrial Clubs of America, Inc., 1025 15th Street N.W., Washington, D.C. 20005.

VICA
UNIT I

INFORMATION SHEET

I. Purposes of the VICA organization

   A. To unite in a common bond all students enrolled in trade and industrial education

   B. To develop leadership abilities through participation in educational, vocational, civic, recreational, and social activities

   C. To foster a deep respect for the DIGNITY OF WORK

   D. To assist students in establishing realistic vocational goals

   E. To help students attain a purposeful life

   F. To create enthusiasm for learning

   G. To promote high standards in trade ethics, workmanship, scholarship, and safety

   H. To develop the ability of students to plan together, organize, and carry out worthy activities and projects through use of the democratic process

   I. To foster a wholesome understanding of the functions of labor and management organizations and a recognition of their mutual interdependence

   J. To create among students, faculty members, patrons of the school, and persons in business and labor a sincere interest in and esteem for trade, industrial, and technical education

   K. To develop patriotism through a knowledge of our Nation's heritage and the practice of DEMOCRACY

II. VICA motto--Preparing for Leadership in the World of Work

III. VICA pledge--UPON MY HONOR, I pledge

   A. To prepare myself by diligent study and ardent practice to become a worker whose services will be recognized as honorable by my employer and fellow workers

   B. To base my expectations of reward upon the solid foundation of service

   C. To honor and respect my vocation in such a way as to bring repute to myself

INFORMATION SHEET

   D. And further, to spare no effort in upholding the ideals of the Vocational Industrial Clubs of America

IV. VICA creed--Emphasizes a belief in

   A. The dignity of work

   B. The American way of life

   C. Education

   D. Fair play

   E. Satisfaction achieved by good work

   F. High moral and spiritual standards

V. Colors of the VICA organization

   A. Red and white--Represent the individual states and clubs

   B. Blue--Represents the common union of the states and of the clubs

   C. Gold--Represents the individual

VI. Symbols of the VICA emblem (Transparency 1)

   A. Shield--Represents patriotism

   B. Torch--Represents knowledge

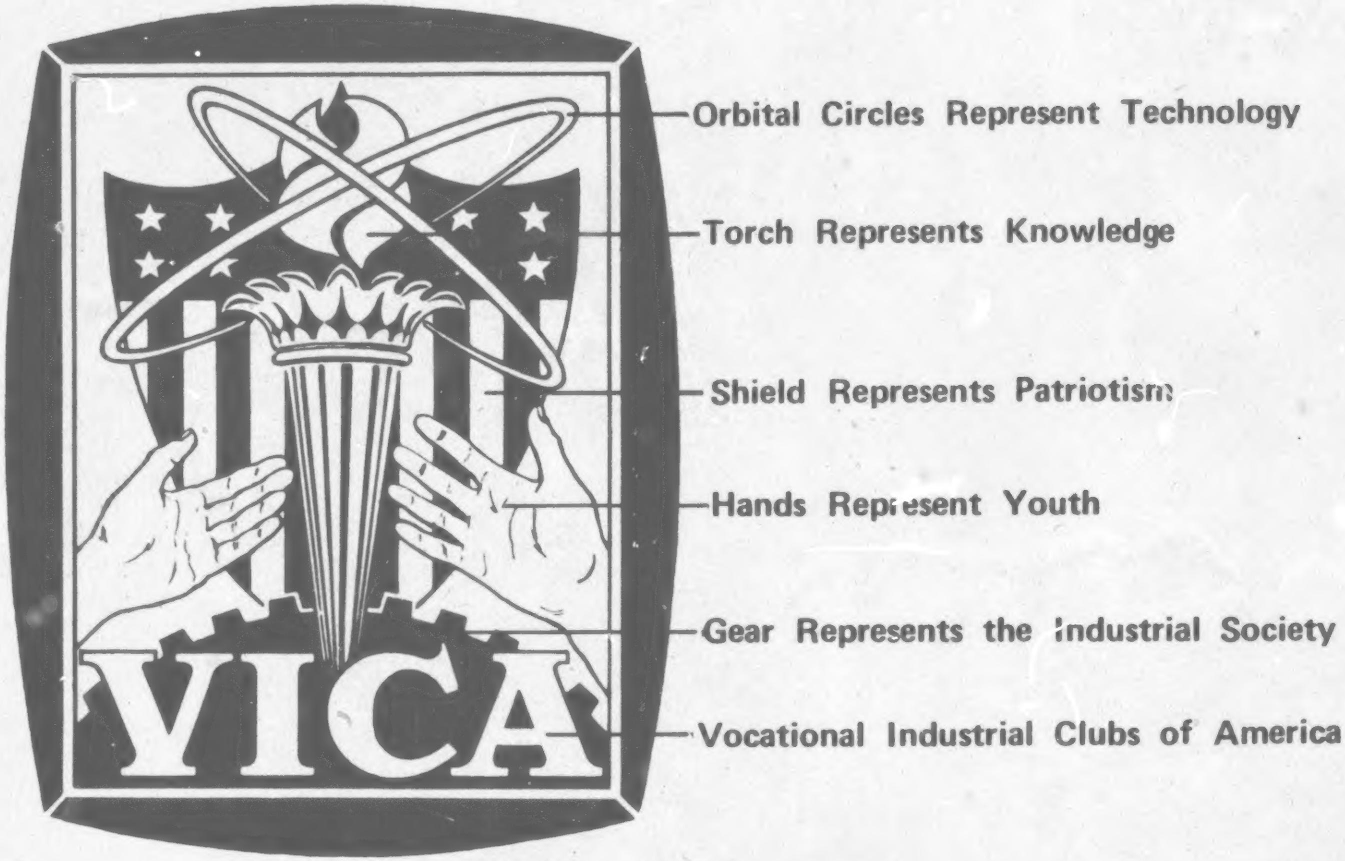
   C. Orbital circles--Represent technology

   D. Gear--Represents the industrial society

   E. Hands--Represent youth

   F. VICA--Represents Vocational Industrial Clubs of America

Symbols of the VICA Emblem


Orbital Circles Represent Technology
Torch Represents Knowledge
Shield Represents Patriotism
Hands Represent Youth
Gear Represents the Industrial Society
Vocational Industrial Clubs of America
VICA

VICA
UNIT I

TEST

1. Name five purposes of the VICA organization.

   a.

   b.

   c.

   d.

   e.

2. Write the VICA motto.

3. Write the VICA pledge.

   Upon my honor I pledge:

   a. To prepare myself--

   b. To base my expectations--

   c. To honor and respect--

   d. And further--

4. Name four beliefs the VICA creed emphasizes.

   a.

   b.

   c.

   d.

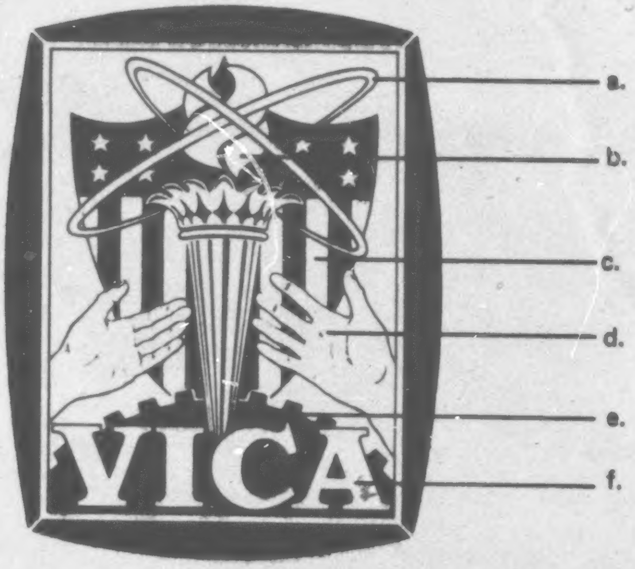
5. Write what each color of the VICA organization represents.

   a. Red and white--

   b. Blue--

   c. Gold--

6. Identify the following symbols and tell what each symbol represents.



a. ____________ Represents ____________

____

b. ____________ Represents ____________

____

c. ____________ Represents ____________

____

d. ____________ Represents ____________

____

e. ____________ Represents ____________

____

f. ____________ Represents ____________

____

VICA
UNIT I

ANSWERS TO TEST

1. Any five of the following

   a. To unite in a common bond all students enrolled in trade and industrial education

   b. To develop leadership abilities through participation in educational, vocational, civic, recreational, and social activities

   c. To foster a deep respect for the DIGNITY OF WORK

   d. To assist students in establishing realistic vocational goals

   e. To help students attain a purposeful life

   f. To create enthusiasm for learning

   g. To promote high standards in trade ethics, workmanship, scholarship, and safety

   h. To develop the ability of students to plan together, organize, and carry out worthy activities and projects through use of the democratic process

   i. To foster a wholesome understanding of the functions of labor and management organizations and a recognition of their mutual interdependence

   j. To create among students, faculty members, patrons of the school, and persons in business and labor a sincere interest in and esteem for trade, industrial, and technical education

   k. To develop patriotism through a knowledge of our Nation's heritage and the practice of DEMOCRACY

2. VICA motto--Preparing for Leadership in the World of Work

3. VICA pledge--UPON MY HONOR, I pledge

   a. To prepare myself by diligent study and ardent practice to become a worker whose services will be recognized as honorable by my employer and fellow workers

   b. To base my expectations of reward upon the solid foundation of service

   c. To honor and respect my vocation in such a way as to bring repute to myself

d. And further, to spare no effort in upholding the ideals of the Vocational Industrial Clubs of America

4. Any four of the following
   - a. The dignity of work
   - b. The American way of life
   - c. Education
   - d. Fair play
   - e. Satisfaction achieved by good work
   - f. High moral and spiritual standards

5. a. Red and white--Represent the individual states and clubs
   - b. Blue--Represents the common union of the states and of the clubs
   - c. Gold--Represents the individual

6. a. Orbital circles--Represent technology
   - b. Torch--Represents knowledge
   - c. Shield--Represents patriotism
   - d. Hands--Represent youth
   - e. Gear--Represents the industrial society
   - f. VICA--Represents Vocational Industrial Clubs of America

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to apply principles of parliamentary procedure and list characteristics of a good chairman. He should be able to match types of motions with their purpose and list characteristics of motions used in conducting a meeting. He should be able to list purposes of a speech, characteristics of a speech, and write and deliver a speech. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. List two principles upon which parliamentary procedure is based.
2. List three characteristics of a good chairman.
3. Match the types of motions with the appropriate definition.
4. Write the order of business for a meeting.
5. Write the characteristics of the kinds of motions used in conducting a meeting.
6. List three purposes for making a speech.
7. Write the outline most speeches follow.
8. List the three "ups" of speech delivery.
9. Demonstrate the ability to:
    a. Use parliamentary procedure correctly.
    b. Write and deliver a three to five minute speech.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information sheet.

  C. Discuss terminal and specific objectives.

  D. Have students conduct a business meeting using correct parliamentary procedure.

  E. Have students give speeches.

  F. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Participate in discussion in business meetings and serve as chairman at least once.

  D. Write and deliver a speech.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Test

  D. Answers to test

II. References:

  A. Gray, Jarrell D. *Parliamentary Guide for Vocational Industrial Club of America.* Wolfe City, Texas: Texas Association Inc., Henington Publishing Company.

B. Sturgis, Alice F. *Parliamentary Procedure.* New York: McGraw-Hill Book Company, Inc.

III. Additional materials:

A. "Workbook of Parliamentary Guide for Vocational Industrial Clubs of America," Vocational Industrial Clubs of America, Oklahoma Association. State Department of Vocational and Technical Education, 1515 West Sixth Street, Stillwater, Oklahoma 74074 (15¢). Teachers Key to Workbook, free.

B. Gray, Jarrell D. *Parliamentary Guide for Vocational Industrial Clubs of America.* Texas Association, Inc. (35¢). Order from: Dr. Jarrell D. Gray, Box 717, Commerce, Texas 75428.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

INFORMATION SHEET

I. Principles upon which parliamentary procedure is based

   A. The right of the majority to rule

   B. The right of the minority to be heard and protected

II. Characteristics of a chairman

   A. Be impartial

   B. Inspire confidence in the members

   C. Provide leadership

III. Types of motions

   A. Main motion

      1. Main idea before the meeting

      2. Only one main motion before the meeting

   B. Amendments--Change a main motion

   C. Motion to reconsider--Close debate

   D. Motion to adjourn--End the meeting

   E. Questions of privilege--Protect rights and comforts of members

   F. Privileged motion

      1. Must be disposed of immediately

      2. Kinds of privileged motions

         a. Adjournment

         b. Call for orders of the day

         c. Fix time of next meeting

   G. Rising to a point of order--Belief of error in procedure

   H. Appeals--Dissatisfaction with a decision of the chair

INFORMATION SHEET

IV. Order of business for a meeting

  A. Opening ceremony

  B. Minutes of previous meeting

  C. Unfinished or old business

  D. Committee reports

  E. New business

  F. Closing ceremony

  G. Entertainment, recreation, refreshments

V. Table of motions and rules that apply to motions (Extra sheet)

VI. Purposes for making a speech

  A. To inform

  B. To entertain

  C. To persuade

VII. Speech outline

  A. Introduction

  B. Discussion

  C. Conclusion

VIII. Three "ups" of speech delivery

  A. Stand up (avoid leaning on podium)

  B. Speak up

  C. Shut up (short conclusion)

INFORMATION SHEET

V. Table of Motions and Rules That Apply to Motions

Motions	May Interrupt Speaker	Required Second	Debatable	Vote Required	Motion That May Apply
A. Privileged					
1. To fix time	No	Yes	Limited	Maj.	Amend, Reconsider
2. To adjourn	No	Yes	No	Maj.	None
3. To take a recess	No	Yes	Limited	Maj.	Amend
4. Question of privilege	Yes	No	No	Chmn.rules	All
5. Call for order of day	Yes	No	No	None	None
B. Incidental					
1. Point of order	Yes	No	No or Maj.	Chmn.rules	None
2. Appeal	Yes	Yes	Yes	Maj.	All except amend
3. Suspend rules	No	Yes	No	2/3	None
4. Withdraw a motion	No	No	No	Maj.	Reconsider
5. Parliamentary inquiry	Yes	No	No or Maj.	Chmn.rules	None
6. Object to consider	Yes	No	No	2/3	All
7. Call for division of the house	Yes	No	No	Maj.	All
8. To call for a division of a question	No	Yes	No	Maj.	All
C. Subsidiary					
1. Lay on table	No	Yes	No	Maj.	None
2. Previous question	No	Yes	No	2/3	Reconsider
3. Refer to committee	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques.
4. Amend	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques.
5. Postpone indefinitely	No	Yes	Yes	Maj.	Limit Deb., Prev. Ques., Recon.
D. Main Motions					
1. General main motion	No	Yes	Yes	Maj.	All
2. Specific main motion					
a. To take from table	No	Yes	No	Maj.	None
b. To reconsider	Yes	Yes	Yes	Maj.	Lim. Deb., Prev. Ques., Table
c. To adopt a resolution	No	Yes	Yes	Maj.	All
d. To adjourn	No	Yes	Limited	Maj.	Amend, Reconsider
e. To create order of day	No	Yes	Yes	Gen.,Maj., Spec. 2/3	All
f. To amend	No	Yes	Yes	Maj.	Amend, Recon., Prev. Ques. Lim. Deb.

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

TEST

1. List two principles upon which parliamentary procedure is based.

   a.

   b.

2. List three characteristics of a good chairman.

   a.

   b.

   c.

3. Match the types of motions with the appropriate definition.

   ______a. To end meeting

   ______b. To close debate

   ______c. Main idea before the group

   ______d. To change the main idea

   ______e. Used when the chair has made an error

   1. Main motion

   2. Amendment

   3. Adjournment

   4. To reconsider

   5. Point of order

4. Write the first three items in the order of business for a meeting.

   a.

   b.

   c.

5. Write the characteristics of motions by filling in the blanks in the following table.

	Second Required	Debatable	Amendable	Vote Required
a. Main motion				
b. Amendment				
c. Adjournment				
d. Lay on table				
e. Point of order				

6. List three purposes for making a speech.

a.

b.

c.

7. Write the outline form that most speeches follow.

a.

b.

c.

8. List the three "ups" of speech delivery.

a.

b.

c.

9. The student should demonstrate the ability to perform the following, to the satisfaction of the instructor.

a. Use parliamentary procedure correctly.

b. Write and deliver a three to five minute speech.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

PARLIAMENTARY PROCEDURE AND PUBLIC SPEAKING
UNIT II

ANSWERS TO TEST

1. a. The right of the majority to rule

   b. The right of the minority to be heard and protected

2. a. Be impartial

   b. Inspire confidence in the members

   c. Provide leadership

3. a. 3

   b. 4

   c. 1

   d. 2

   e. 5

4. a. Opening ceremony

   b. Minutes of previous meeting

   c. Unfinished or old business

5.	a.	Main motion	Yes	Yes	Yes	Majority
	b.	Amendment	Yes	Yes	Yes	Majority
	c.	Adjournment	Yes	No	No	Majority
	d.	Lay on table	Yes	No	No	Majority
	e.	Point of order	No	No	No	None

6. a. To inform

   b. To entertain

   c. To persuade

7. a. Introduction

   b. Discussion

   c. Conclusion

8. a. Stand up (avoid leaning on podium)
   b. Speak up
   c. Shut up (short conclusion)
9. Performance skills on the use of parliamentary procedure and the prepared speech will be evaluated by the instructor.

BECOMING A GOOD LEADER
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name characteristics of a good leader, discuss desirable leadership qualities, and demonstrate an ability to lead others. The student should identify with leadership qualities by taking the Personality Self-Rating Scale. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define leadership.
2. Name five characteristics of a good leader.
3. Discuss in a short paragraph why becoming a good leader is desirable.
4. Name four steps to becoming a good leader.
5. Name five values of having leadership ability.
6. Identify with leadership qualities by taking the Personality Self-Rating Scale.
7. Identify some leaders within the local community and list three factors that identify each as a leader.

BECOMING A GOOD LEADER
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Discuss terminal and specific objectives.

   D. Discuss information and assignment sheets.

   E. Help evaluate the student according to the Personality Self-Rating Scale.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Assignment sheets

      1. Assignment Sheet #1-Personality Self-Rating Scale

      2. Assignment Sheet #2-Identifying Leaders Within Your Community

   D. Test

   E. Answers to test

II. References:

A. *Official Manual.* Future Farmers of America, Alexandria, Virginia, 1971.

B. Gray, Jarrell D. and J. R. Jackson. *Leadership Training and Parliamentary Procedure for FFA.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1958.

C. *Animal Science.* Missouri State Department of Education, Agricultural Education Section, University of Missouri, Columbia, Missouri.

BECOMING A GOOD LEADER
UNIT III

INFORMATION SHEET

I. Leadership--The combination of qualities which inspires confidence, draws others toward the leader, and causes them to follow

II. Characteristics of a good leader

   A. Preparedness--Know leadership takes work as well as practice

   B. Group-mindedness--Regard yourself as a part of the group. Say "we" instead of "I"; do not try to run the crowd. Instead, be guided by the crowd's wishes

   C. Consideration for others--Be understanding and friendly

   D. Poise--Do not let irritations bother you

   E. Humility--Be confident, but not cocky; do not be afraid to reveal you do not know everything

   F. Hard work--Do not ask anyone to do something that you would not be willing to do yourself

   G. Responsibility--Live up to your work and duties

   H. Cooperativeness--Know how to work with others and enjoy working with them

   I. Happiness--Enjoy life; the simple things as well as the big

   J. Imagination--Help the persons in your group to learn and grow through the activities

   K. Preciseness--Be able to express yourself effectively

   L. Pride--Take pride in what you do; take pride in being a leader, but earn it

   M. Neatness--Always be neat in dress and personal appearance

   N. Courtesy--The words "please" and "thank you" pay dividends; use them often

   O. Understanding--Know members' opinions and be ready to meet changing situations

   P. Ambition--Set goals and make them high, but be sure to reach them

INFORMATION SHEET

- Q. Open-mindedness--Take advice, but do your own thinking
- R. Curiosity--Analyze all the facts before you draw conclusions
- S. Energy--Do your best at all times, plan to make the most effective use of your time

III. Reasons to become a good leader

- A. Self-satisfaction
- B. Leadership needed in all fields
- C. Challenge to learn
- D. Creates respect for others
- E. Aids in maturity

IV. Steps in becoming a good leader

- A. Leaders are made, not born
- B. Study qualities of a good leader
- C. Evaluate weak and strong points of yourself
- D. Become a good follower
- E. Develop a plan for training yourself as a leader

V. Values of having leadership ability

- A. Education
- B. Respect
- C. Advancement in an occupation
- D. Financial betterment
- E. Pride
- F. Security

BECOMING A GOOD LEADER
UNIT III

ASSIGNMENT SHEET #1--PERSONALITY SELF-RATING SCALE

Circle the appropriate number following each trait. Four is outstanding, three is above average, two is average, one is poor. Total your score below.

1. Do I maintain a well-groomed appearance? 1 2 3 4
2. Do I have a pleasing voice? 1 2 3 4
3. Is my posture alert and poised? 1 2 3 4
4. Is my disposition cheerful? 1 2 3 4
5. Do I make friends easily? 1 2 3 4
6. Do I exert a positive leadership? 1 2 3 4
7. Am I generally thoughtful of the feelings of others? 1 2 3 4
8. Is my enthusiasm sincere and contagious? 1 2 3 4
9. Do I persevere until I achieve success? 1 2 3 4
10. Am I sincere in my interest in other people? 1 2 3 4
11. Am I ambitious to get ahead? 1 2 3 4
12. Do I get along well with others? 1 2 3 4
13. Do I react constructively to criticism? 1 2 3 4
14. Do I remember names and faces? 1 2 3 4
15. Am I punctual on all occasions? 1 2 3 4
16. Do I have and evidence a spirit of cooperation? 1 2 3 4
17. Am I free from prejudice? 1 2 3 4
18. Do I know how people react in most situations? 1 2 3 4
19. Am I generally a good listener? 1 2 3 4
20. Do I refuse to allow what other people say hurt me? 1 2 3 4

ASSIGNMENT SHEET #1

21. Can I criticize without giving offense? 1 2 3 4

22. Do I usually like people for what they are, or do I wait to see if they like me? 1 2 3 4

23. Do I enjoy being part of a group? 1 2 3 4

24. Am I reliable? 1 2 3 4

25. Can I adapt myself to all situations? 1 2 3 4

26. Am I easily discouraged? 1 2 3 4

27. Do I apply myself to the problems of each day? 1 2 3 4

28. Can I make a decision quickly and accurately? 1 2 3 4

29. Am I loyal to my superiors and associates? 1 2 3 4

30. Do I try to get the other fellow's point of view? 1 2 3 4

31. Am I neat and clean in my work as well as my personal appearance? 1 2 3 4

32. Do I know where I make my mistakes, and do I admit them? 1 2 3 4

33. Am I looking for opportunities to serve others better? 1 2 3 4

34. Am I following a systematic plan for improvement and advancement? 1 2 3 4

35. Can I accept honors and advancements and yet keep my feet on the ground? 1 2 3 4

36. Am I playing the game of life honestly and fairly with myself, my fellow members, and others with whom I work? 1 2 3 4

Total Score ___________

BECOMING A GOOD LEADER
UNIT III

EVALUATION OF ASSIGNMENT SHEET #1

Now to evaluate your scores--If your score totaled over 100, your personality rating is definitely superior and if you have been honest with yourself, you are among the people who are most likely to succeed. 90 - 100 is above average. 75 - 90 is average. Below 75 shows plenty of room for improvement. How did you rate?

BECOMING A GOOD LEADER
UNIT III

ASSIGNMENT SHEET #2 - IDENTIFYING LEADERS WITHIN YOUR COMMUNITY

Identify three individuals in your local community which appear to you as good leaders. After you have identified the leaders, list three factors that identify them as such.

NAME	LEADERSHIP QUALITIES
1. ________________	a. ________________
	b. ________________
	c. ________________
2. ________________	a. ________________
	b. ________________
	c. ________________
3. ________________	a. ________________
	b. ________________
	c. ________________

BECOMING A GOOD LEADER
UNIT III

TEST

1. Define leadership.

2. Name five characteristics of a good leader.

   a.

   b.

   c.

   d.

   e.

3. Discuss in a short paragraph why becoming a good leader is desirable.

4. Name four steps to becoming a good leader?

   a.

   b.

   c.

   d.

5. Name five values of having leadership ability.

   a.

   b.

   c.

   d.

   e.

6. Identify with leadership qualities by taking the Personality Self-Rating Scale.

7. Identify some leaders within the local community and list three factors that identify each as a leader.

(NOTE: If items 6 and 7 have not been accomplished prior to the test, ask the instructor when these activities should be completed.)

BECOMING A GOOD LEADER
UNIT III

ANSWERS TO TEST

1. Leadership--The combination of qualities which inspires confidence, draws others toward the leader, and causes them to follow.

2. Any five of the following

   a. Preparedness

   b. Group-mindedness

   c. Consideration for others

   d. Poise

   e. Humility

   f. Hard work

   g. Responsibility

   h. Cooperativeness

   i. Happiness

   j. Imagination

   k. Preciseness

   l. Pride

   m. Neatness

   n. Courtesy

   o. Understanding

   p. Ambition

   q. Open-mindedness

   r. Curiosity

   s. Energy

3. Discussion should include the following

   a. Leadership needed in all fields

- b. Challenge to learn
- c. Creates respect for others
- d. Aids in maturity
- e. Self-satisfaction
- f. Other items that instructor felt was necessary

4. Any four of the following
   - a. Leaders are made, not born
   - b. Study qualities of a good leader
   - c. Evaluate weak and strong points of yourself
   - d. Become a good follower
   - e. Develop a plan for training yourself as a leader
5. Any five of the following
   - a. Education
   - b. Respect
   - c. Advancement in an occupation
   - d. Financial betterment
   - e. Pride
   - f. Security
6. Evaluated to the satisfaction of the instructor.
7. Evaluated to the satisfaction of the instructor.

APPLYING FOR A JOB
UNIT IV

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to locate a job opening, make formal application, and effectively interview for a job. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with a job application to the correct definition.
2. List five means of locating job openings.
3. List three methods of applying for a job.
4. Select ten items of information that may be asked on an application.
5. Select from a list the attributes or attitudes an employer looks for during a personal interview.
6. Identify examples of proper conduct during the job interview.
7. Demonstrate the ability to:
    a. Write a letter of application for a job.
    b. Make an appointment by phone for a job interview.
    c. Write a resume.
    d. Complete an application form for a job.
    e. Write a follow-up letter after an interview for a job.

APPLYING FOR A JOB
UNIT IV

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information, assignment, and handout sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Discuss assignment sheets and handouts.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets and handouts.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Attitudes

      2. TM 2--Take Time To Be On Time

      3. TM 3--Appropriate Dress

D. Assignment sheets

  1. Assignment Sheet #1–Write a Letter of Application
  2. Assignment Sheet #2–Complete an Application
  3. Assignment Sheet #3–Prepare a Resume
  4. Assignment Sheet #4–Write a Follow-Up Letter

E. Student handouts

  1. Student Handout #1–Application for Employment
  2. Student Handout #2–Dear Kid
  3. Student Handout #3–Sample Letter of Application
  4. Student Handout #4–Sample Resume
  5. Student Handout #5–Sample Follow-Up Letter

F. Test

G. Answers to test

II. References:

A. Blackledge - Blackledge - Keily. *You and Your Job.* Dallas, Texas: South-Western Publishing Company, 1967.

B. Milburn, Paul M. *How to Get a Job.* Shawnee, Oklahoma: Gordon Cooper Area Vocational Technical School, 1967.

C. Moynihan - Moynihan - Daeger. *You and Your Job--How to Get It.* Chicago, Illinois: J. G. Ferguson Publishing Company, 1968.

D. Wood - McKeena. *The Receptionist.* Dallas, Texas: Gregg Division, McGraw-Hill Book Company, 1966.

APPLYING FOR A JOB
UNIT IV

INFORMATION SHEET

I. Terms and definitions

  A. Awards--Recognition received for outstanding achievement

  B. Extra-curricular activities--The clubs, organizations, and social or church groups in which one participates

  C. Fringe benefits--The extras provided by an employer such as paid vacations, sick leave, and insurance protection

  D. Qualifications--The experience, education, and physical characteristics which suit a person to a job

  E. Resume--A brief typed summary of one's qualifications and experience that is used in applying for a job

  F. Vocational preparation--Any vocational courses and skills one has learned in high school or through work experience

II. Means of locating a job opening

  A. Classified ads

    1. Newspapers

    2. Magazines

  B. Employment offices

    1. Department of labor

    2. Private

  C. Local labor union business office

  D. School officials

    1. Teacher

    2. Counselor

    3. Principal

  E. Direct contact with employer

INFORMATION SHEET

III. *Methods of applying for a job*

- A. Letter
- B. Telephone
- C. In person

IV. Information that may be asked on an application (Student Handout #1)

- A. Name and address
- B. Phone number
- C. Social Security Number
- D. Personal information
  - 1. Age
  - 2. Sex
  - 3. Height
  - 4. Weight
  - 5. Physical limitations
- E. Education
  - 1. Elementary
  - 2. High school
  - 3. College
  - 4. Other
- F. Experience (Including military)
- G. Next of kin
- H. Previous employers
- I. Reason for leaving last job
- J. Type of job for which one is applying
- K. References
- L. Resume (optional)

INFORMATION SHEET

V. Personal attributes or attitudes (Transparency 1)

   A. Enthusiasm and interest

   B. Dedication and dependability

   C. Alertness, quickness of mind

   D. Honesty and integrity

   E. Desire to work

   F. Desire to help others

   G. Desire to improve one's self

VI. Proper conduct during the interview (Transparencies 2 and 3; Student Handout #2)

   A. Greet interviewer with a warm smile

   B. Call interviewer by name (Mr., Mrs., or Miss Jones)

   C. Introduce self

   D. Shake interviewers hand firmly

   E. Be seated only after interviewer has asked

   F. Sit and stand erect; do not lean against the wall, a chair, or the desk

   G. Do not put a hat or coat on the interviewer's desk

   H. Let the interviewer take the lead in the conversation

   I. Answer questions completely

   J. Be polite and courteous

      1. Do not interrupt

      2. Say "Yes, sir" or "No, sir"

   K. Have resume and examples of work available for quick reference

   L. Make an extra effort to express one's self clearly and distinctly

      1. Take time to think through every answer

      2. Use proper grammar

INFORMATION SHEET

        3. Do not swear

        4. Avoid use of slang

        5. Try to understand the interviewer's position

        6. Look the interviewer in the eye

    M. Be sincere and enthusiastic

    N. Avoid irritating or distracting habits:

        1. Smoking, chewing gum, eating candy

        2. Giggling or squirming in chair

        3. Finger tapping and/or swinging a crossed leg

    O. Do not try to flatter the interviewer

    P. Tell the truth about qualifications and experiences

    Q. Speak well of former employers and associates

    R. Be positive

    S. Accept competition gracefully

    T. Watch for a sign that the interview is over

    U. Thank interviewer for his time

    V. Leave promptly at completion of interview

VII. Writing a letter of application (Student Handout #3)

    A. Make sure the letter meets the standards below:

        1. Attractive form

        2. Logical arrangement of information

        3. Free from smudges or typographical errors

        4. Free from spelling or gramatical errors

        5. Brief and to the point--Leave the details for the resume

        6. Positive in tone

        7. Clearly expressed ideas

INFORMATION SHEET

B. The following information should be included in a letter of application

1. Type of position for which one is applying
2. Reason interested in position and firm
3. Ways one's training meets the employer's needs
4. Explanation of personal qualifications
5. Mention of resume
6. Request for interview

   (NOTE: Be sure to include an address and a phone number where you can be reached.)

VIII. Making an appointment by phone for an interview

A. Steps to follow in making an appointment

1. Plan what to say before calling
2. State one's name and reason for calling

   (NOTE: Remember that the receptionist is there to help you. Keep her on your side.)

3. Ask when would be the best time to come for an interview

   (NOTE: Do not ask over the phone how much the job pays.)

4. Record the day, time, and place for the interview
5. Thank the receptionist for her help

   (NOTE: Be polite and courteous. Remember that this is your first contact with the firm. Make that first impression a good one.)

IX. Preparing a resume (Student Handout #4)

A. Standards for a resume

1. Logically organized
2. Neatly typed
3. Error free
4. In outline form

INFORMATION SHEET

5. Limited to one page if possible

6. Honest listing of qualifications and experience

B. Information to include in a resume

1. Name, address, and phone number

2. Recent photograph

3. Personal data

    a. Birth date

    b. Age, height, and weight

    c. Physical limitations

    d. Marital status

    e. Hobbies

4. Education

    a. Schools attended

    b. Dates of attendance

    c. Major field of study

    d. Awards and activities

5. Job preferences

6. Experience

    a. Name and address of company

    b. Length of time worked

    c. Brief description of duties and responsibilities

    d. Special training programs or courses

7. References (usually three)

    (NOTE: Be sure to obtain permission before naming someone as a reference.)

INFORMATION SHEET

X. Writing a follow-up letter (Student Handout #5)

   A. Make sure this letter meets the following standards:

      1. Error free

      2. Clean, neat, and arranged attractively

      3. Free from spelling, punctuation, and grammatical errors

      4. Sent within a day or two after the interview

   B. Points to include in a follow-up letter

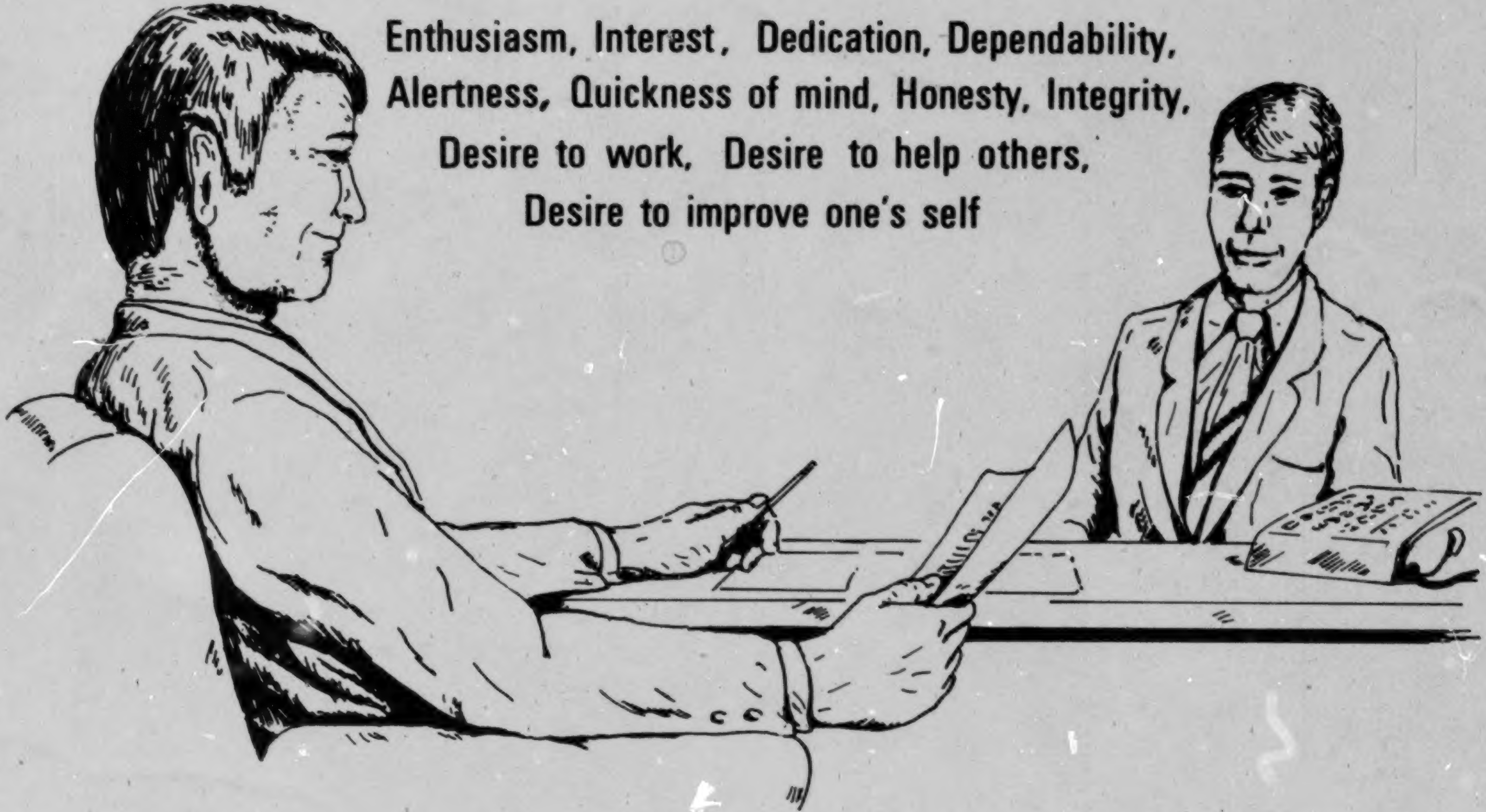
      1. An expression of appreciation for the interviewer's time and interest

      2. A summary of personal qualifications and interest in the position

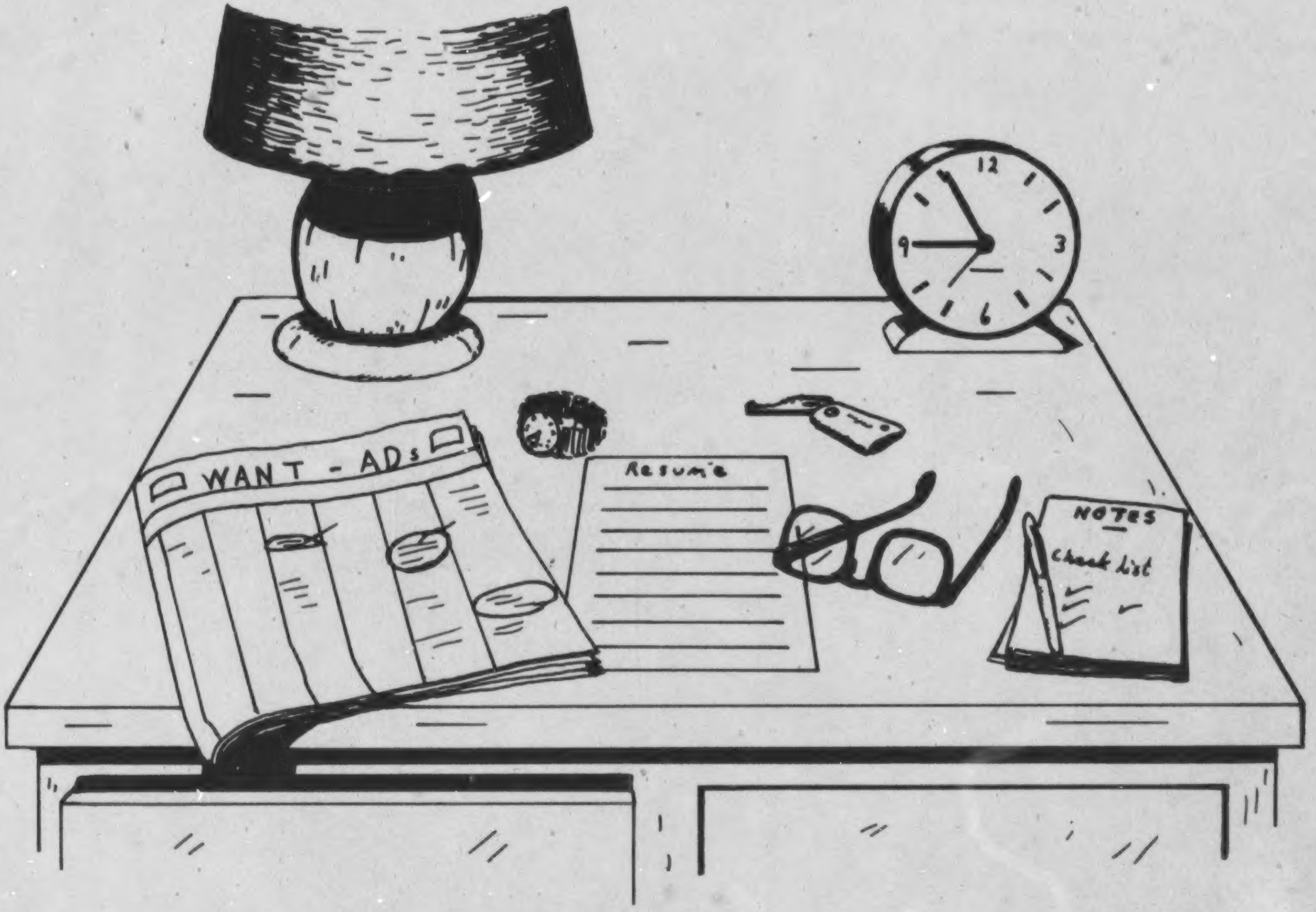
         (NOTE: Make this last bid for the job a prime example of your excellent work habits. Make the letter as clean, neat, and well worded as possible.)

Attitudes

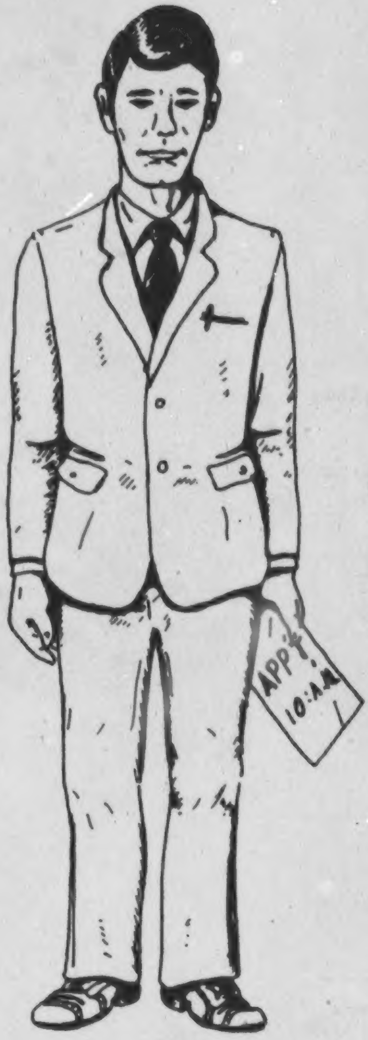
Enthusiasm, Interest, Dedication, Dependability,
Alertness, Quickness of mind, Honesty, Integrity,
Desire to work, Desire to help others,
Desire to improve one's self



Take the Time to be on Time


12
3
6
9
WANT - ADs
Resumé
NOTES
Check list

Appropriate Dress



Hair-neat?

Friendly?

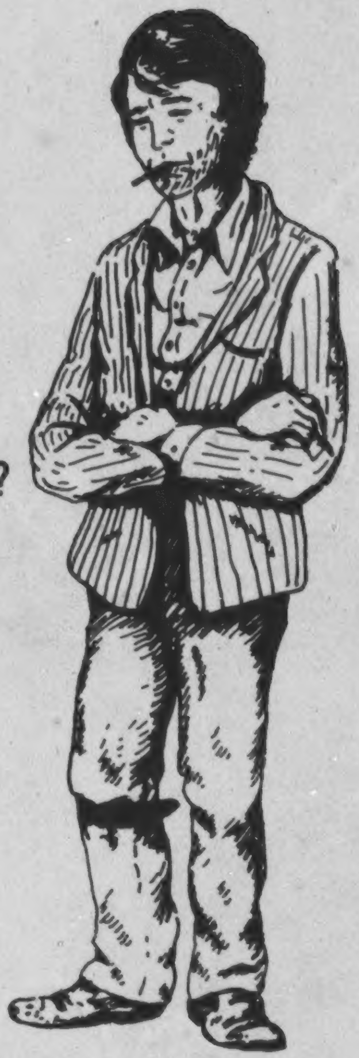
Clean shave?

Clean and neat clothes?

Pen and paper?

On time?

Shoes shined?



APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #1--WRITE A LETTER OF APPLICATION

Directions:

A. Write a letter of application to a prospective employer of your choice. Use the sample letter in Handout #3 as a guide in composing the letter.

B. Make sure the letter meets the standards outlined in the information sheet.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #2--COMPLETE AN APPLICATION

Directions:

View this form (Handout #1) as an application for employment in the occupation of your choice. Fill in the required information being as honest and realistic as possible.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #3--PREPARE A RESUME

Directions:

A. Write a resume to be included with a letter of application. Use the example in Handout #4 as a guide.

B. Make sure this resume meets the standards outlined in the information sheet.

APPLYING FOR A JOB
UNIT IV

ASSIGNMENT SHEET #4--WRITE A FOLLOW-UP LETTER

Directions:

A. Write a follow-up letter to the prospective employer used in Assignment Sheet #1. Use the sample letter in Handout #5 as a guide in composing the letter.

B. Make sure this letter meets the standards outlined in the information sheet.

APPLYING FOR A JOB UNIT IV STUDENT HANDOUT #1

APPLICATION FOR EMPLOYMENT

Do not print

Date ____________ Position applied for ____________

Name ____________ Height ________ Weight ________ Age ________

Address ____________________ Telephone No. ____________
(Street or RFD) (City) (State)

Previous address ____________ Social Security No. ____________

Birthdate ____________ Birthplace ____________
(Month) (Day) (Year) (City) (State)

CHECK ALL THAT APPLY:

_____ Female
_____ Male
_____ Single
_____ Married
_____ Widowed
_____ Divorced
_____ Separated

_____ Own home
_____ Rent
_____ Board
_____ Live (Parents)
_____ With (Relatives)
_____ Purchasing home

Number and age of dependents:
____
Relationship of dependents:
____
Business or occupations of father:
____
(or Husband) ____________

Interested in: Temporary work _____ Full-time _____ Part-time _____ Saturday only _____
Salary expected ____________
Are you responsible for your entire support? _____ Others who are dependent on you for their support: Number _____ Ages ____________
Nature of any physical defects ____________
Recent illnesses ____________
Date of last physical examination ____________

EDUCATION	Circle grade completed	Name of School	Location	Major Subject	Year Graduated
Elementary	1 2 3 4 5 6 7 8				
High	1 2 3 4				
Business or Vocational	1 2 3 4				
College or University	1 2 3 4 5 6				
Night or Correspondence	1 2 3 4				

Give details of any other educational training ____________
____

STUDENT HANDOUT #1

What are your hobbies? ________

In case of illness or emergency, notify: Name ________

Address ________

Relationship ________ Telephone ________

Why do you feel qualified for the position for which you are applying?

____

____

____

PREVIOUS EMPLOYMENT

(Last employment-first)

From	To	Name & address of employer	Department-position duties -- salary	Reason for Leaving
Month ____ Year	Month ____ Year			
Month ____ Year	Month ____ Year			
Month ____ Year	Month ____ Year			
Month ____ Year	Month ____ Year			

PERSONAL REFERENCES

(Do not give names of relatives or former employers)

	Name	Address	Occupation
1.			
2.			
3.			

Do Not Write In Space Below

Interviewed by:

Personality ________

Attitude ________

Ambition and initiative ________

Other remarks:

Calmness ________

Physical qualities ________

Intelligence ________

Leadership ________

Appearance and grooming ________

Work best suited for ________

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #2--DEAR KID

Dear Kid:

Today you asked me for a job. From the look of your shoulders as you walked out, I suspect you've been turned down before, and maybe you believe by now that kids out of high school can't find work.

But, I hired a teen-ager today. You saw him. He was the one with the polished shoes and a necktie. What was so special about him? Not experience, neither of you had any. It was his attidude that put him on the payroll instead of you. Attitude son. ATTITUDE. He wanted that job badly enough to shuck the leather jacket, get a haircut, and look in the phone book to find out what this company makes. He did his best to impress me. That's where he edged you out.

You see, Kid, people who hire people aren't "with" a lot of things and we have some Stone Age ideas about who owes whom a living. Maybe that makes us prehistoric, but there's nothing wrong with the checks we sign, and if you want one you'd better tune to our wave length.

Ever hear of "empathy?" It's the trick of seeing the other fellow's side of things. I couldn't have cared less that you're behind in your car payments. That's your problem and the president's. What I needed was someone who'd go out in the plant, keep his eyes open, and work for me like he'd work for himself. If you have even the vaguest idea of what I'm trying to say, let it show the next time you ask for a job. You'll be head and shoulders over the rest.

Look kid. The only time jobs grew on trees was while most of the manpower was wearing G.I.'s and pulling K.P. For all the rest of history you've had to get a job like you get a girl: "Case" the situation, wear a clean shirt, and try to appear reasonably willing.

Maybe jobs aren't as plentiful right now, but a lot of us can remember when master craftsmen walked the streets. By comparison you don't know the meaning of "scarce."

You may not believe it, but all around you employers are looking for young men smart enough to go after a job in the old-fashioned way. When they find one, they can't wait to unload some of their worries on him.

For both our sakes, get eager, will you?

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #3--SAMPLE LETTER OF APPLICATION

Mr. John Jones
Personnel Director
Jones Construction Company
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Please consider me for the job of rough framing carpenter that you advertised in the Daily Chronicle.

The skills I have learned in my high school vocational carpentry courses should qualify me for this job. I have had experience in all of the basic skills required in residential construction including the safe use of power tools.

I will be graduating from high school in May, and I would like to become a carpenter. A more complete description of my qualifications is given in the enclosed resume.

May I come for an interview any time at your convenience? I can be reached by phone at 377-3303 after 3:30 p.m. or by mail at 774 East Adams Street, Anywhere, U.S.A. 77704.

Sincerely yours,

James F. Smith

Encl. 1

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #4--SAMPLE RESUME

Name: James L. Smith
Address: 774 E. Adams St., Anywhere, U.S.A. 77704
Telephone: 377-3303

Age: 18 years
Height: 6' - 1"
Weight: 180 pounds
Health: Excellent
Marital Status: Single

Education: Expect to graduate from high school May 1973

Subjects Studied:

Vocational carpentry--2 years (1080 hours)
Algebra--2 semesters
Geometry--2 semesters
Basic drafting--2 semesters
Industrial arts wood working--2 semesters

Student activities:

President, Senior class
President, VICA
Treasurer, Baptist youth fellowship
Carpentry contest, 1st place State, 3rd place National

Work experience:

Carpenter's helper, Jones Construction Co., Summer 1972
Vocational Carpentry Class 1972-73, all phases of construction
Mr. Sammy Slavedriver, Instructor

References:

Mr. Sammy Slavedriver
Vocational Carpentry Instructor
Anywhere High School
Anywhere, U.S.A. 77704

Mr. John Naildriver
Construction Foreman
Jones Construction Company
2330 Lake Shore Drive
Anywhere, U.S.A. 77704

Mr. Jimmie Smith
Youth Director
Park View Baptist Church
711 Fellowship Circle
Anywhere, U.S.A. 77704

Date compiled______________________________

Signature__________________________________

APPLYING FOR A JOB
UNIT IV

STUDENT HANDOUT #5–SAMPLE FOLLOW-UP LETTER

Mr. John Jones
Personnel Director
Jones Construction Company
Box 19
Anywhere, U.S.A. 77704

Dear Mr. Jones:

Thank you for interviewing me for the rough framing carpenter job in your firm. I feel that working for Jones Construction Company would be enjoyable and that I could do the general rough framing work that the job requires. I hope that I will have the opportunity to prove my worth.

The application form you gave me is enclosed.

I will be available for work May 15. You may call me at my home after 3:30 p.m. The number is 377-3303.

Sincerely yours,

James L. Smith

encl.

APPLYING FOR A JOB
UNIT III

TEST

1. Match the terms with a job application to the correct definition.

_____a. A brief typed summary of one's qualifications and experiences that is used in applying for a job

_____b. The extras provided by an employer such as paid vacations, sick leave, and insurance protection

_____c. Recognition received for outstanding achievement

_____d. The experience, education, and physical characteristics which suit a person to a job

_____e. Any vocational courses and skills one has learned in high school or through work experience

_____f. The clubs, organizations, and social or church groups in which one participates

1. Awards
2. Extra-curricular activities
3. Fringe benefits
4. Qualifications
5. Resume
6. Vocational preparation

2. List five means of locating job openings.

a.

b.

c.

d.

e.

3. List three methods of applying for a job.

a.

b.

c.

4. Select ten items of information that may be asked for on an application.

_____a.

_____b.

_____c.

_____d.

_____e.

_____f.

_____g.

_____h.

_____i.

_____j.

1. Race
2. Name and address
3. Phone number
4. Shoe size
5. Age
6. Education
7. Number of brothers and sisters
8. Experience
9. Next of kin
10. Make and model of car
11. Previous employers
12. Reason for leaving last job
13. Are you left or right handed
14. Type of job for which one is applying
15. References

5. Select seven personal attributes or attitudes that an employer looks for.

_____a.

_____b.

_____c.

_____d.

_____e.

_____f.

_____g.

1. Alertness
2. Long wavy hair
3. Dedication and dependability
4. Enthusiasm and interest
5. New car
6. Honesty and integrity
7. Desire to work
8. Beard
9. Flashy clothes
10. Desire to help others
11. Desire to improve one's self

6. Identify ten examples of proper conduct during an interview.

_____a.

_____b.

_____c.

_____d.

_____e.

_____f.

_____g.

_____h.

_____i.

_____j.

1. Arrive five minutes late as it gives the impression that one is busy
2. Sit and stand erect
3. Call interviewer by his or her first name
4. Answer questions completely
5. Put a hat or coat on the interviewer's desk
6. Greet interviewer with a warm smile
7. Sit down immediately upon entering the room
8. Shake the interviewer's hand firmly
9. Be polite and courteous
10. Use all of the cute slang expressions
11. Look the interviewer in the eye
12. Be sincere and enthusiastic
13. Thank the interviewer for his time
14. Chain smoke (gives the impression of being a real "he-man")
15. Speak well of former employees
16. Flatter the interviewer
17. Leave promptly at completion of interview

7. Demonstrate the ability to:

a. Write a letter of application for a job.

b. Make an appointment by phone for a job interview.

c. Write a resume.

d. Complete an application form for a job.

e. Write a follow-up letter after an interview for a job.

(NOTE: If this has not been accomplished prior to the test, ask your instructor when the above activities should be completed.)

APPLYING FOR A JOB
UNIT IV

ANSWERS TO TEST

1. a. 5
   b. 3
   c. 1
   d. 4
   e. 6
   f. 2
2. a. Classified ads
   b. Employment offices
   c. Local labor union business office
   d. School officials
   e. Direct contact with employer
3. a. Letter
   b. Telephone
   c. In person

(IMPORTANT: The answers for 4, 5, and 6 may be given in any order.)

4. a. 2
   b. 3
   c. 5
   d. 6
   e. 8
   f. 9
   g. 11
   h. 12
   i. 14
   j. 15

5. a. 1
   b. 3
   c. 4
   d. 6
   e. 7
   f. 10
   g. 11
6. a. 2
   b. 4
   c. 6
   d. 8
   e. 9
   f. 11
   g. 12
   h. 13
   i. 15
   j. 17
7. Performance skills will be evaluated to the satisfaction of the instructor.

MEASURING
UNIT V

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to define measuring terms and identify the basic tools used in measuring. He should be able to read a rule in feet, inches, and fractions of inches down to one-sixteenth of an inch. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with measuring to a list of definitions.
2. Identify five basic tools used in measuring.
3. Read a rule to the nearest one-sixteenth of an inch.
4. Demonstrate the ability to perform the following measuring skills:
    a. Measure objects to the nearest sixteenth of an inch when given pictures of objects and a measuring instrument.
    b. Draw lines and objects to specified dimensions.

MEASURING
UNIT V

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and assignment sheets.

   C. Make transparencies.

   D. Discuss terminal and specific objectives.

   E. Discuss information and assignment sheets.

   F. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Complete assignment sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objective sheet

   B. Information sheet

   C. Transparency masters

      1. TM 1--Measuring Tools

      2. TM 2--Graduations on a Rule

      3. TM 3--Reading the Eighths Rule

      4. TM 4--Reading the Sixteenths Rule

D. Assignment sheets

  1. Assignment Sheet #1--Reading a Rule
  2. Assignment Sheet #2--Measuring Objects
  3. Assignment Sheet #3--Drawing Lines and Objects

E. Answers to assignment sheets

F. Test

G. Answers to test

II. References:

A. McDonnell, Leo P. *Hand Woodworking Tools.* Albany, New York: Delmar Publishers, 1962.

B. Division of Stanley Works, Educational Department. *Stanley Tool Guide.* New Britain, Connecticut: Stanley Tools, 1972.

MEASURING
UNIT V

INFORMATION SHEET

1. Terms and definitions

   A. Measuring--The setting of limits or bounds according to a predetermined standard

   B. Inch--The smallest whole unit of lineal measure commonly used

   C. Foot--A unit of measure consisting of twelve equal parts called inches

   D. Fraction--One or more equal parts of a whole

   Example: 1/2, 1/4, 3/8, 5/16

   E. Rule--An instrument that is graduated in whole units and fractions of units and used in measuring

   F. Dimension--The number of full units and fractions of units between two points

   G. Modular--Standardized units or dimensions for flexibility and variety in use

II. Basic measuring tools (Transparency 1)

   A. Steel rule

   B. Steel square

   C. Steel tape

   D. Outside calipher

   E. Combination square

III. Reading a rule (Transparencies 2, 3, and 4)

   A. All rules read similarly

   (NOTE: Some rules are graduated with more divisions per inch than others.)

   B. Procedures for reading

      1. Determine the number of graduations per inch

         a. Locate small figure at the "0" end of rule which designates the divisions per inch

INFORMATION SHEET

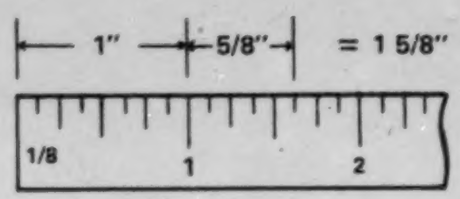
   b. Count the divisions in one inch

   c. Gain skill in determining the divisions through practice

2. Determine inches and fractions of an inch

   a. Count the graduations in that fraction of an inch beyond the last full inch

   Example:



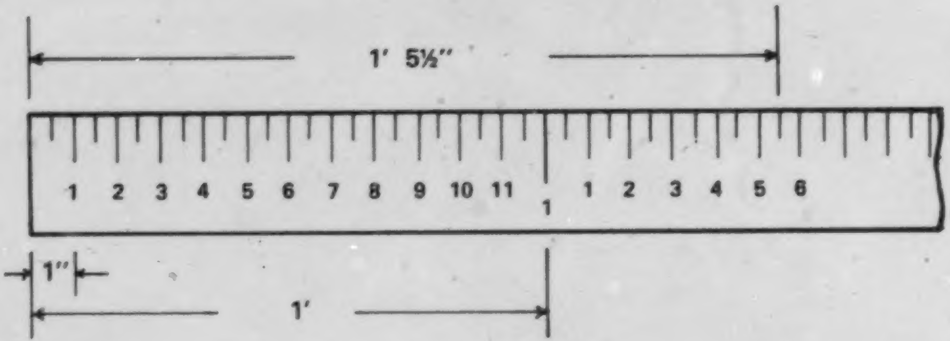
   b. Add the fraction to the last full inch

   (NOTE: In the above example, the total amount equals one and five-eighths inch.)

3. Reduce the fraction if possible

4. Determine the feet and add the inches and fraction of an inch to obtain a correct measurement

   Example:



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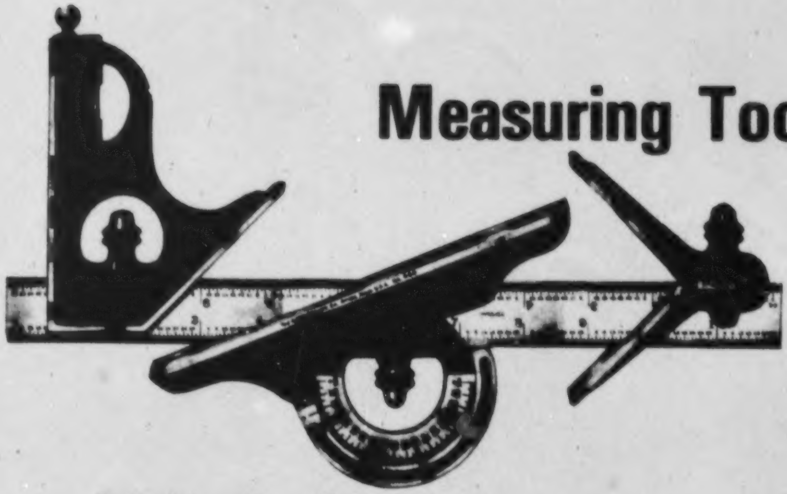
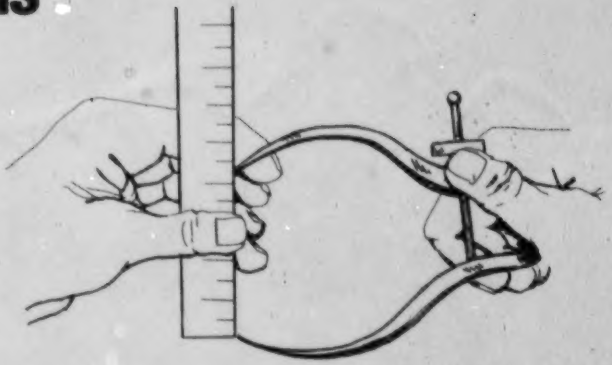
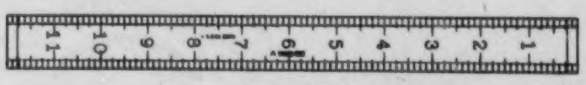
Measuring Tools



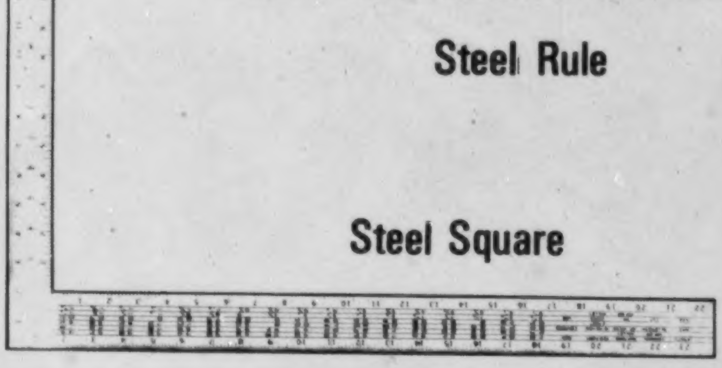
Combination Square



Outside Caliphers

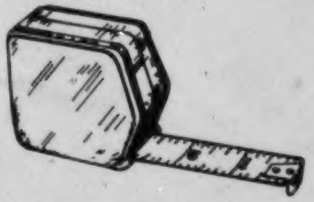


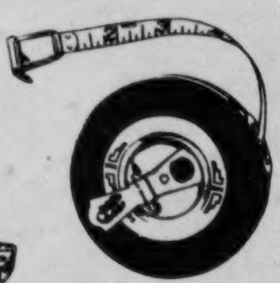
Steel Rule



Steel Square

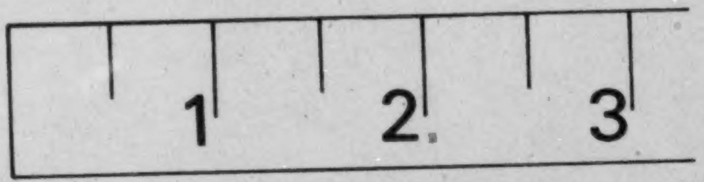
Steel Tapes



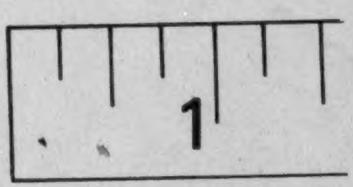


Graduations on a Rule

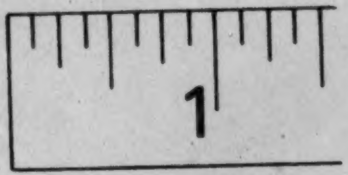
Halves



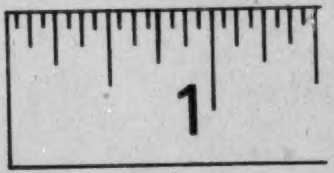
Quarters



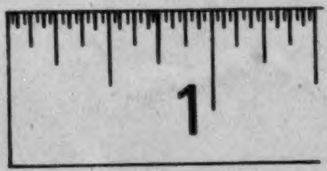
Eighths

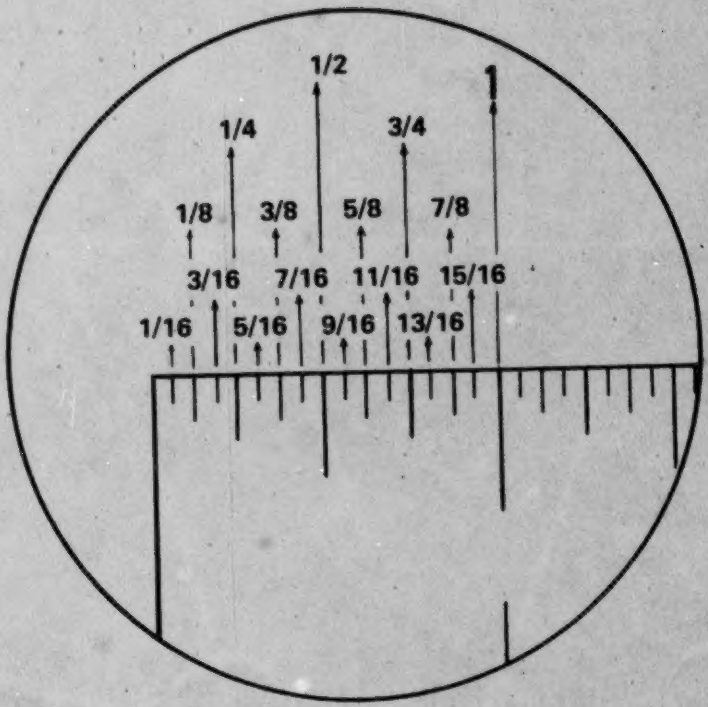


Sixteenths



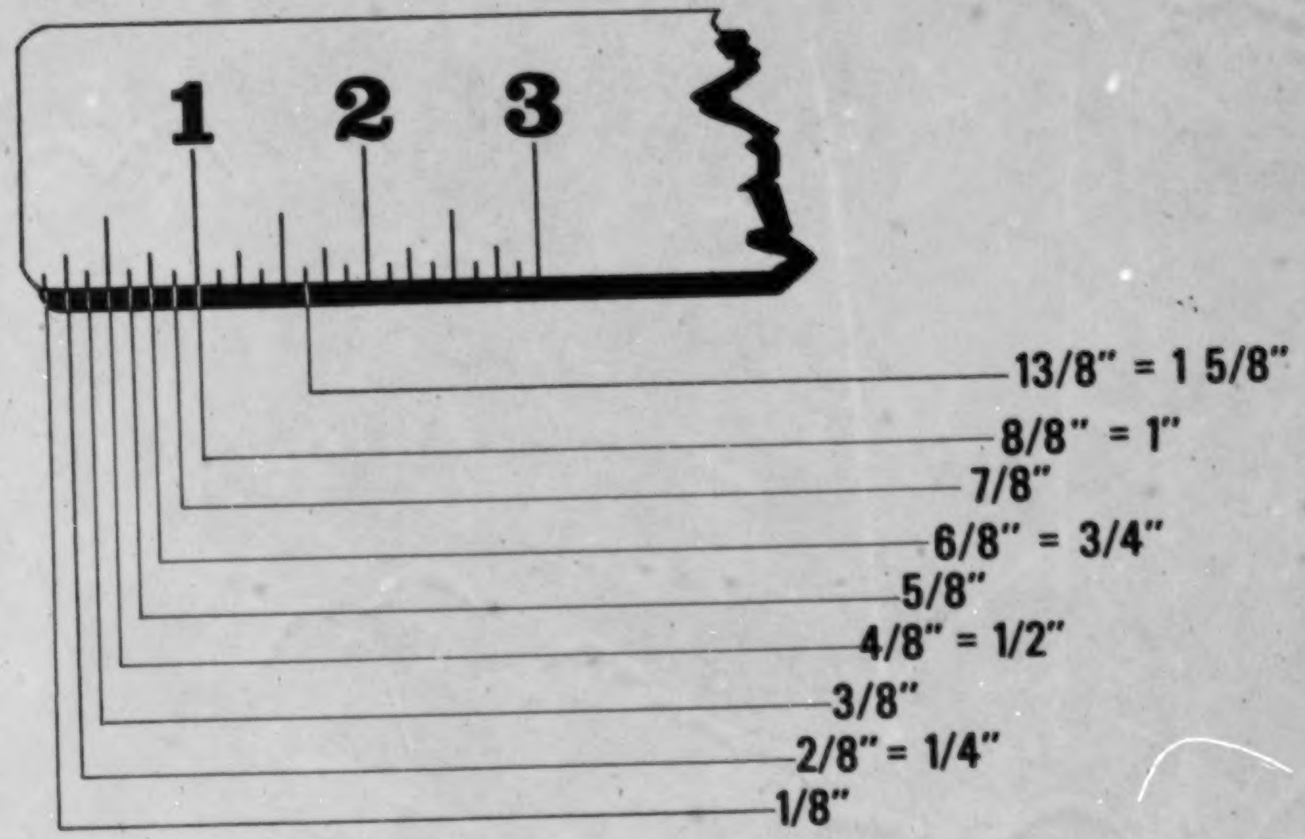
Thirty-Seconds



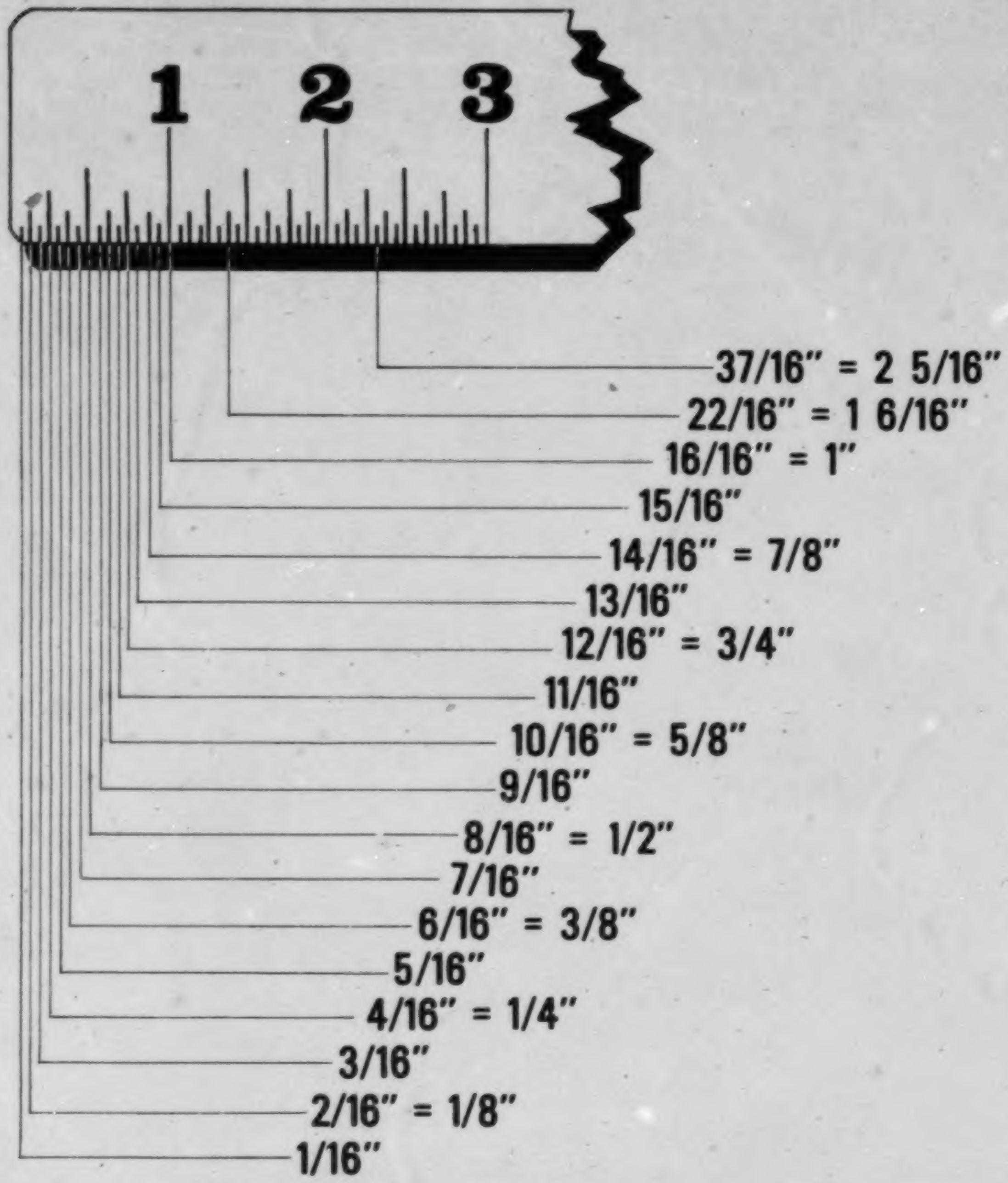

1/2
1
1/4
3/4
1/8
3/8
5/8
7/8
3/16
7/16
11/16
15/16
1/16
5/16
9/16
13/16

Graduations Applied to a Rule

Reading the Eighths Rule


1
2
3
13/8" = 1 5/8"
8/8" = 1"
7/8"
6/8" = 3/4"
5/8"
4/8" = 1/2"
3/8"
2/8" = 1/4"
1/8"

Reading the Sixteenths Rule

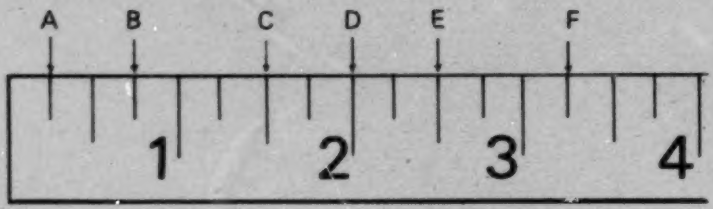

1
2
3
37/16" = 2 5/16"
22/16" = 1 6/16"
16/16" = 1"
15/16"
14/16" = 7/8"
13/16"
12/16" = 3/4"
11/16"
10/16" = 5/8"
9/16"
8/16" = 1/2"
7/16"
6/16" = 3/8"
5/16"
4/16" = 1/4"
3/16"
2/16" = 1/8"
1/16"

]

MEASURING
UNIT V

ASSIGNMENT SHEET #1--READING A RULE

1. Use the drawing below and read the rule to the nearest one-fourth inch.



a. 0-A__________

b. 0-B__________

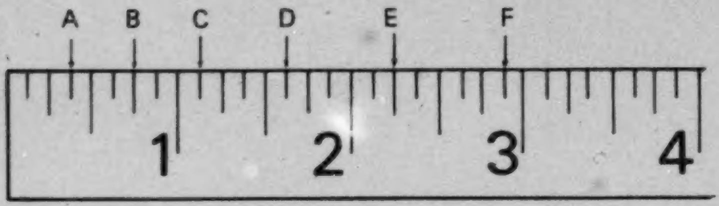
c. 0-C__________

d. 0-D__________

e. 0-E__________

f. 0-F__________

2. Use the drawing below and read the rule to the nearest one-eighth inch.



a. 0-A__________

b. 0-B__________

c. 0-C__________

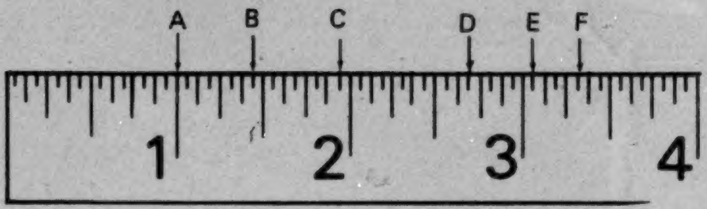
d. 0-D__________

e. 0-E__________

f. 0-F__________

ASSIGNMENT SHEET #1

3. Use the drawing below and read the rule to the nearest one-sixteenth inch.


A
B
C
D
E
F
1
2
3
4

a. 0-A__________

b. 0-B__________

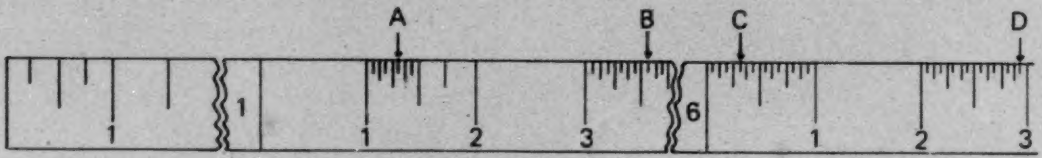
c. 0-C__________

d. 0-D__________

e. 0-E__________

f. 0-F__________

4. Use the drawing below and read the rule to the nearest one-sixteenth inch.


A
B
C
D
1
1
1
2
3
6
1
2
3

a. 0-A__________

b. 0-B__________

c. 0-C__________

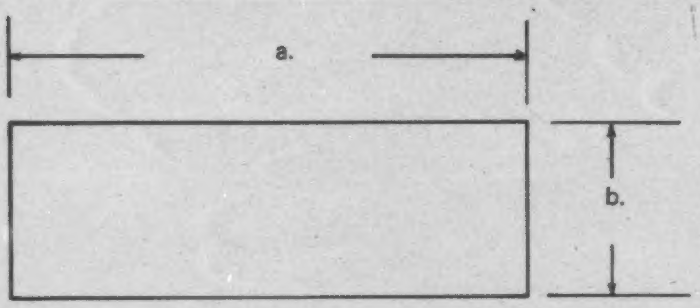
d. 0-D__________

MEASURING
UNIT V

ASSIGNMENT SHEET #2--MEASURING OBJECTS

Using a rule with one-sixteenth inch graduations, measure the following objects.

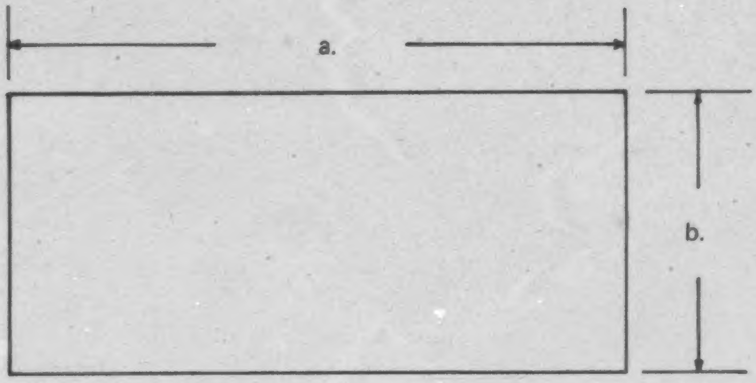
1.



a. Length____________

b. Height____________

2.

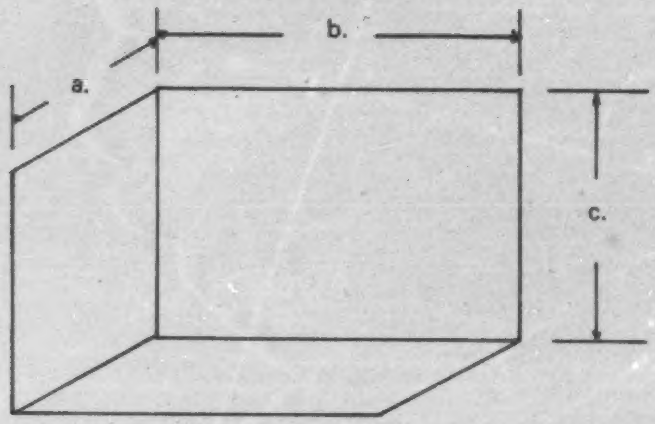


a. Length____________

b. Height____________

ASSIGNMENT SHEET #2

3.

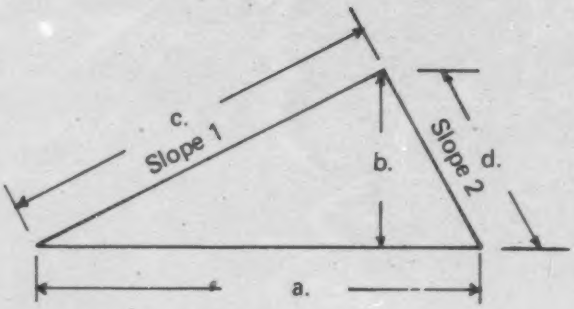


a. Width__________

b. Length__________

c. Height__________

4.


c.
Slope 1
b.
Slope 2
d.
a.

a. Base__________

b. Height__________

c. Slope #1__________

d. Slope #2__________

MEASURING
UNIT V

ASSIGNMENT SHEET #3--DRAWING LINES AND OBJECTS

Using a rule with one-sixteenth graduations, draw the following lines and objects to the given dimensions.

1. Draw straight lines to the following lengths:
   a. 3 3/4 inches
   b. 2 1/16 inches
   c. 3 10/16 inches
   d. 5/4 inch
   e. 2 5/8 inches
2. Draw a rectangle with a height of one and seven-eighths inches and a length of two and three-sixteenths inches.

ASSIGNMENT SHEET #3

3. Draw a triangle with a base length of two and one-half inches a height of one and one-half inches and one slope of two and one-eighths inches.

MEASURING
UNIT V

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. a. 1/4 inch
   b. 3/4 inch
   c. 1 1/2 inches
   d. 2 inches
   e. 2 1/2 inches
   f. 3 1/4 inches
2. a. 3/8 inch
   b. 3/4 inch
   c. 1 1/8 inches
   d. 1 5/8 inches
   e. 2 1/4 inches
   f. 2 7/8 inches
3. a. 1 inch
   b. 1 7/16 inches
   c. 1 15/16 inches
   d. 2 11/16 inches
   e. 3 1/16 inches
   f. 3 5/16 inches
4. a. 1 foot 1 5/16 inches
   b. 1 foot 3 9/16 inches
   c. 6 feet 5/16 inch
   d. 6 feet 2 15/16 inches

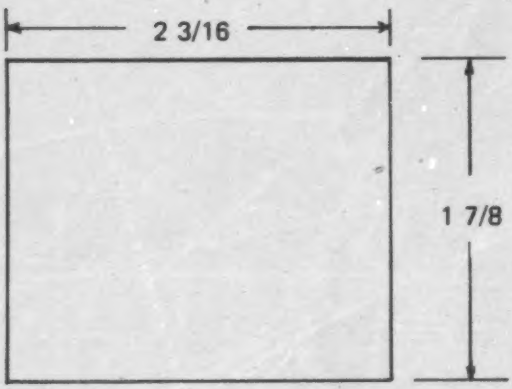
Assignment Sheet #2

1. a. 3 inches
   b. 1 inch
2. a. 3 9/16 inches
   b. 1 5/8 inches
3. a. 1 inch
   b. 2 1/8 inches
   c. 1 7/16 inches
4. a. 2 9/16 inches
   b. 1 1/16 inches
   c. 2 1/4 inches
   d. 3/16 inch

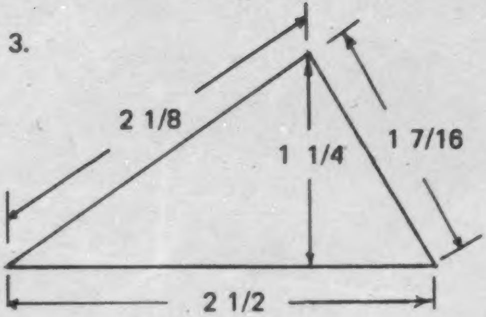
Assignment Sheet #3

1. a. 3 3/4 inches
   b. 2 1/16 inches
   c. 3 5/8 inches
   d. 1 1/4 inches
   e. 2 5/8 inches

2.



3.



MEASURING
UNIT V

TEST

1. Match the following measuring terms to the correct definitions.

_____a. The setting of limits or bounds according to a predetermined standard

_____b. The smallest whole unit of linear measure commonly used

_____c. A unit of measure consisting of twelve equal parts called inches

_____d. One or more equal parts of a whole

_____e. An instrument that is graduated in whole units and fractions of units and used in measuring

_____f. The number of full units and fractions of units between two points

_____g. Standard units or dimensions for flexibility and variety in use

1. Measuring
2. Rule
3. Modular
4. Dimension
5. Inch
6. Fraction
7. Foot

2. Identify the following measuring tools.

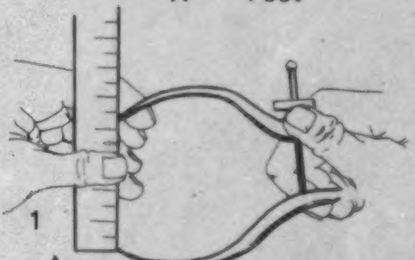
_____a. Steel rule

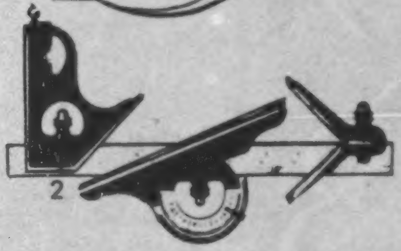
_____b. Steel square

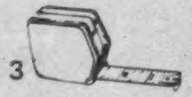
_____c. Steel tape

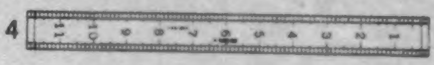
_____d. Outside calipher

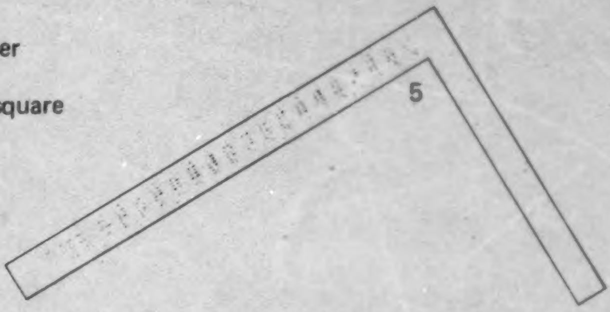
_____e. Combination square











3. Read the rule pictured below to the nearest one-sixteenth of an inch.

______a. 0 to A

______b. 0 to B

______c. 0 to C

______d. 0 to D

______e. 0 to E

______f. 0 to F

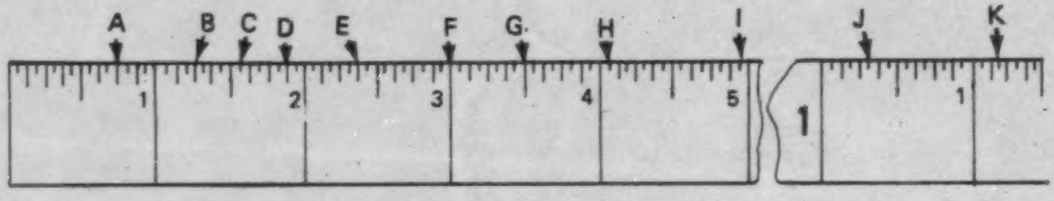
______g. 0 to G

______h. 0 to H

______i. 0 to I

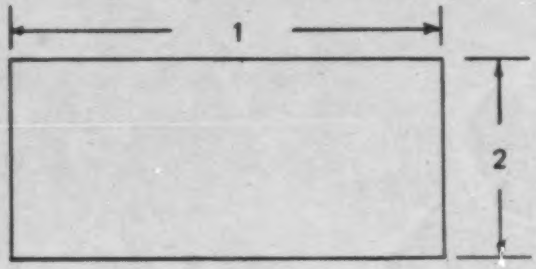
______j. 0 to J

______k. 0 to K



4. Measure the following objects to the nearest one-sixteenth of an inch.

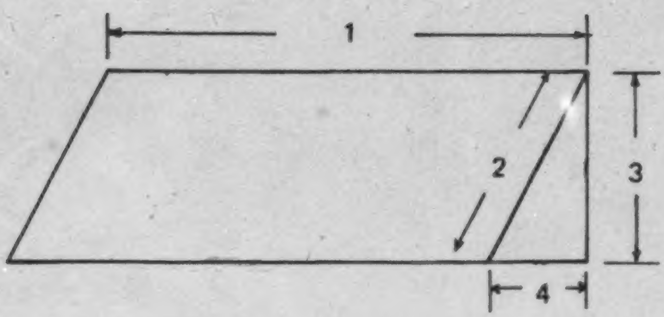
a.



__________1)

__________2)

b.



____________1)

____________2)

____________3)

____________4)

5. Draw objects to the specified dimensions.

   a. Draw a 1 7/8 inch square.

b. Draw a rectangle 1 5/8 x 2 1/4 inches.

c. Draw a triangle with a base line of 2 inches, a height of 7/8 inch, and one slope of 15/16 inch.

MEASURING
UNIT V

ANSWERS TO TEST

1. a. 1
   b. 5
   c. 7
   d. 6
   e. 2
   f. 4
   g. 3
2. a. 4
   b. 5
   c. 3
   d. 1
   e. 2
3. a. 3/4 inch
   b. 1 1/8 inches
   c. 9/16 inch
   d. 1 7/8 inches
   e. 1 3/8 inches
   f. 3 inches
   g. 3 1/2 inches
   h. 4 1/16 inches
   i. 4 15/16 inches
   j. 1 foot 5/16 inch
   k. 1 foot 1 3/16 inches
4. a. 1) 2 7/16 inches
      2) 1 1/16 inches

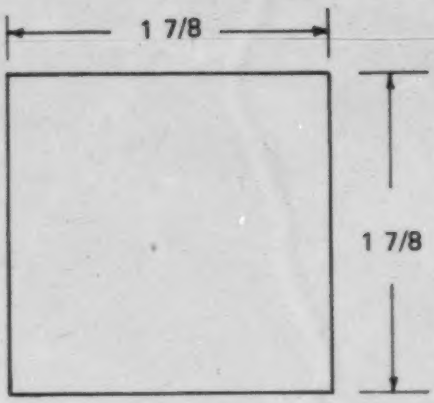
b. 1) 2 3/4 inches

2) 1 3/16 inches

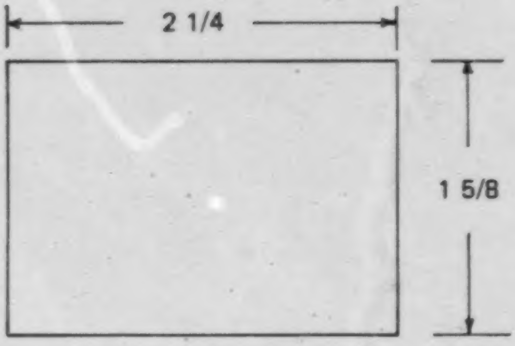
3) 1 1/16 inches

4) 9/16 inch

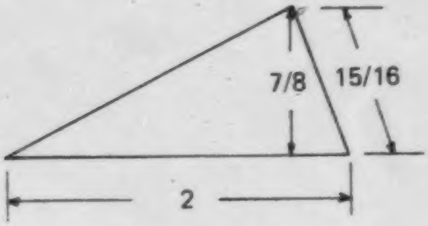
5. a.



b.



c.



BASIC BLUEPRINT READING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to identify pertinent information while examining a blueprint. He should be able to identify the view of a blueprint, read size, and determine dimensions. He should be able to demonstrate his ability to draw a pictorial view and a three-view sketch of a specified rectangular block. This knowledge will be evidence through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with blueprint reading with the correct definition.
2. Select the purpose of a blueprint when given a list of alternatives.
3. Identify the name of the object, company, scale, last change that was made, and the size of the object while examining a blueprint.
4. Name the three major views of a pictorial drawing.
5. Identify the six views as they are arranged on a blueprint.
6. Name the three basic elements of a blueprint.
7. Name three dimensions to look for on a blueprint.
8. Match the basic types of dimensions with their proper function.
9. Identify six common types of lines used in a blueprint.
10. Match fifteen blueprint abbreviations with their corresponding identifications.
11. Read a blueprint identifying views, dimensions, and size in decimal equivalents.
12. Draw a simple three view sketch of a rectangular block eight inches long by one inch wide by one-half inch thick with correct dimensions.

BASIC BLUEPRINT READING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:
   - A. Provide student with objective sheet.
   - B. Provide student with information and assignment sheets.
   - C. Make transparencies.
   - D. Discuss terminal and specific objectives.
   - E. Discuss information and assignment sheets.
   - F. Give test.

II. Student:
   - A. Read objectives.
   - B. Study information sheets.
   - C. Complete assignment sheets.
   - D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:
   - A. Objectives
   - B. Information sheets
   - C. Decimal equivalents
   - D. Transparency masters
      1. TM 1--Converting a Pictorial View into a Three-Sided View
      2. TM 2--Views
      3. TM 3--Types of Dimensions on a Blueprint
      4. TM 4--Basic Lines Used in Blueprint Reading

5. TM 5--Use of Lines on a Blueprint

E. Assignment sheets

1. Assignment Sheet #1--Reading and Interpreting Blueprints
2. Assignment Sheet #2--Drawing a Three-View Sketch

F. Answers to assignment sheets

G. Test

H. Answers to test

II. References:

A. Bennett, A.E., and Louis J. Siy. *Blueprint Reading For Welders.* Albany, New York: Delmar Publishers, Inc.

B. *How to Read Shop Drawings.* Cleveland, Ohio: The Lincoln Electric Company.

C. *Blueprint Reading Series.* Albany, New York: Delmar Publishers, Inc.

BASIC BLUEPRINT READING
UNIT I

INFORMATION SHEET

I. Terms and definitions

  A. Blueprint--A written message conveyed from the draftsman to the workman containing technical information

  B. Dimensions--A process of illustrating the size of various objects

  C. Views--A drawing illustrating the part of an object one could see if standing directly in front

  D. Orthographic projection--A method of illustrating several views of an object

  E. Pictorial view--An illustration showing three or more sides of an object

  F. Size dimension--A type of dimension that tells how large or small an object is

  G. Location dimension--A type of dimension that locates a feature on a object

  H. Size description--The notes and dimensions that tell the size of an object

  I. Shape description--The views that illustrate the shape of an object

II. Purpose of a blueprint--Transmits information from the draftsman to the welder on constructing projects

III. Information found on a blueprint

  A. Description

  B. Date

  C. Object

  D. Company

  E. Scale

  F. Last change

  G. Size of object

  H. Example

INFORMATION SHEET

IV. Major views of a pictorial drawing (Transparency 1)

   A. Top

   B. Front

   C. End

V. Six views of a blueprint (Transparency 2)

   A. Front

   B. Top

   C. Bottom

   D. Left

   E. Right

   F. Rear

VI. Basic elements of a blueprint

   A. Lines--Give shape and dimension to the object

   B. Dimensions--Give size and location of various segments of items being constructed

   C. Notes--Give details of construction not shown by lines

VII. Dimensions to look for on a blueprint

   A. Height

   B. Width

   C. Depth

VIII. Types of dimensions (Transparency 3)

   A. Overall--Describes a total distance such as the complete length, width, or thickness of a part

   B. Size--Gives information concerning the size of a part

   C. Location--Gives information concerning the location of some detail of construction such as a hole

IX. Lines used in blueprint reading (Transparencies 4 and 5)

   A. Border--Serves as a frame for the blueprint

   B. Object--Indicates the outline of an object

INFORMATION SHEET

C. Hidden--Represents an edge that cannot be seen from the outside of the object

D. Extension--Indicates the exact distance the dimension describes

E. Dimension--Extends between the extension lines to clarify dimensions

F. Center--Used to locate the center of a circle or a curved surface

G. Pointer--Shows the detail described by a dimension or note

H. Cutting plane--Used to show the shape of complicated parts

I. Break--Used to show interior detail

X. Common abbreviations used on blueprints

A. C. I. = Cast Iron

B. C. C. = Center to Center

C. C. bore = Counterbore

D. C.R.S. = Cold Rolled Steel

E. C. S. = Cast Steel

F. Csk. = Countersink

G. Dia. = Diameter

H. F = Finish

I. F.A.O. = Finish All Over

J. Fin = Finish

K. F. S. = Full size

L. F.S.D. = Full Size Detail

M. Hex = Hexagon

N. I.D. = Inside Diameter

O. N. C. = National Coarse

P. N. F. = National Fine

Q. No. or # = Number

INFORMATION SHEET

R. O. C. = On Center

S. O. D. = Outside Diameter

T. R. or Rad = Radus

U. Req'd = Required

V. S.A.E. = Society of Automotive Engineers

W. Sq. - Square

X. U.S.S. = United States Standard

Y. N.T.S. = Not to Scale

Z. Cir = Circular

AA. Cyl = Cylinder

BB. Deg or ° = Degree(s)

CC. Ga = Gauge

DD. GI = Galvanized Iron

EE. I = I beam

FF. In. or " = Inch(es)

GG. Mal I = Malleable Iron

HH. Std = Standard

II. Stl = Steel

JJ. Stl C = Steel Casting

KK. Thd or Thds = Thread(s)

LL. WI = Wrought Iron

MM. Br# = Brass, SAE#

NN. Bro# = Bronze, SAE#

OO. Chfr = Chamfer

BASIC BLUEPRINT READING
UNIT I

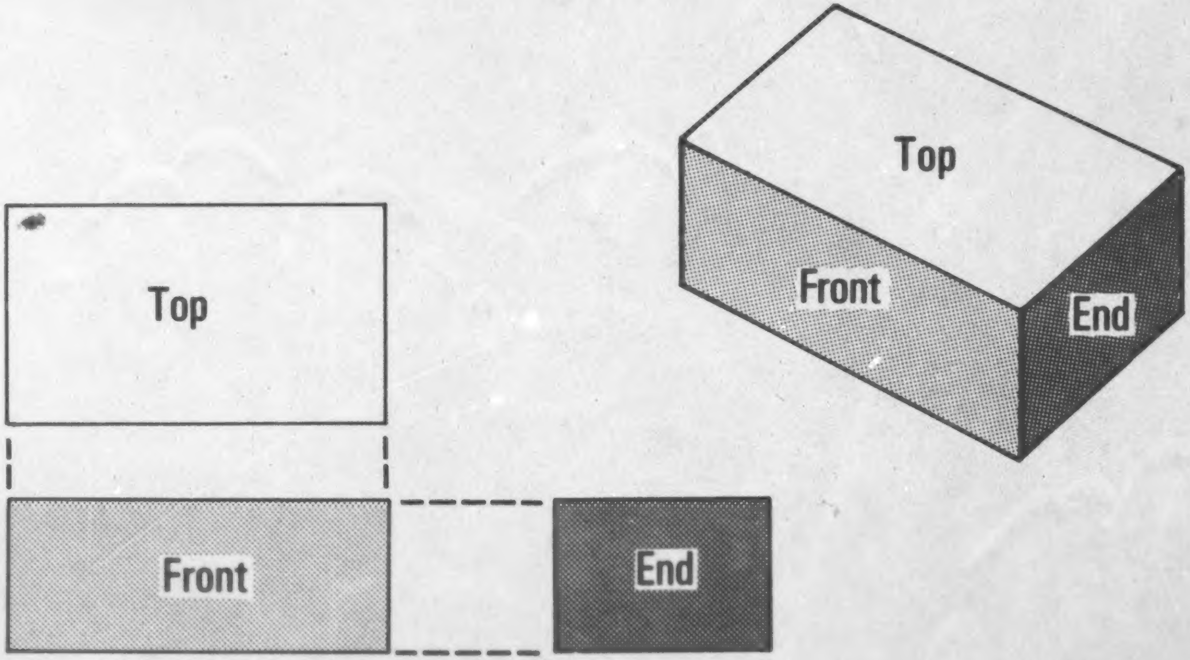
DECIMAL EQUIVALENTS

XI.

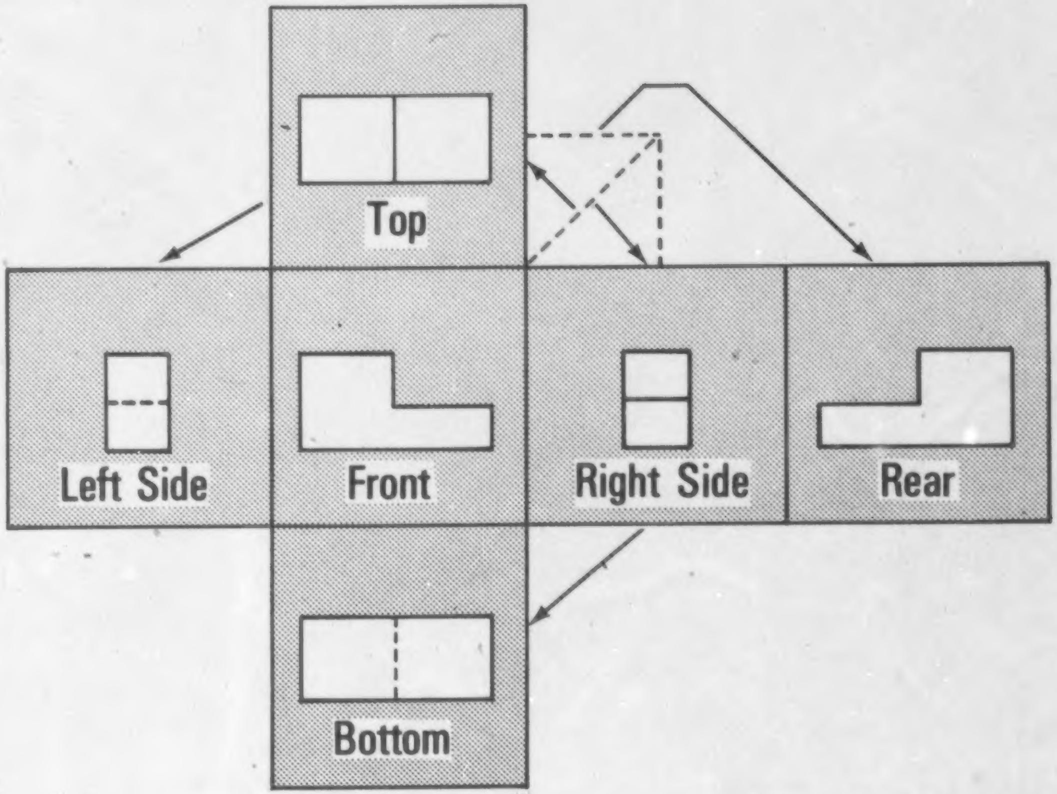
DECIMAL EQUIVALENTS

1/64	.015625
1/32	.03125
3/64	.046875
1/16	.0625
5/64	.078125
3/32	.09375
7/64	.109375
1/8	.125
9/64	.140625
5/32	.15625
11/64	.171875
3/16	.1875
13/64	.203125
7/32	.21875
15/64	.234375
1/4	.25
17/64	.265625
9/32	.28125
19/64	.296875
5/16	.3125
21/64	.328125
11/32	.34375
23/64	.359375
3/8	.375
25/64	.390625
13/32	.40625
27/64	.421875
7/16	.4375
29/64	.453125
15/32	.46875
31/64	.484375
1/2	.5
33/64	.515625
17/32	.53125
35/64	.546875
9/16	.5625
37/64	.578125
19/32	.59375
39/64	.609375
5/8	.625
41/64	.640625
21/32	.65625
43/64	.671875
11/16	.6875
45/64	.703125
23/32	.71875
47/64	.734375
3/4	.75
49/64	.765625
25/32	.78125
51/64	.796875
13/16	.8125
53/64	.828125
27/32	.84375
55/64	.859375
7/8	.875
57/64	.890625
29/32	.90625
59/64	.921875
15/16	.9375
61/64	.953125
31/32	.96875
63/64	.984375
1	1.

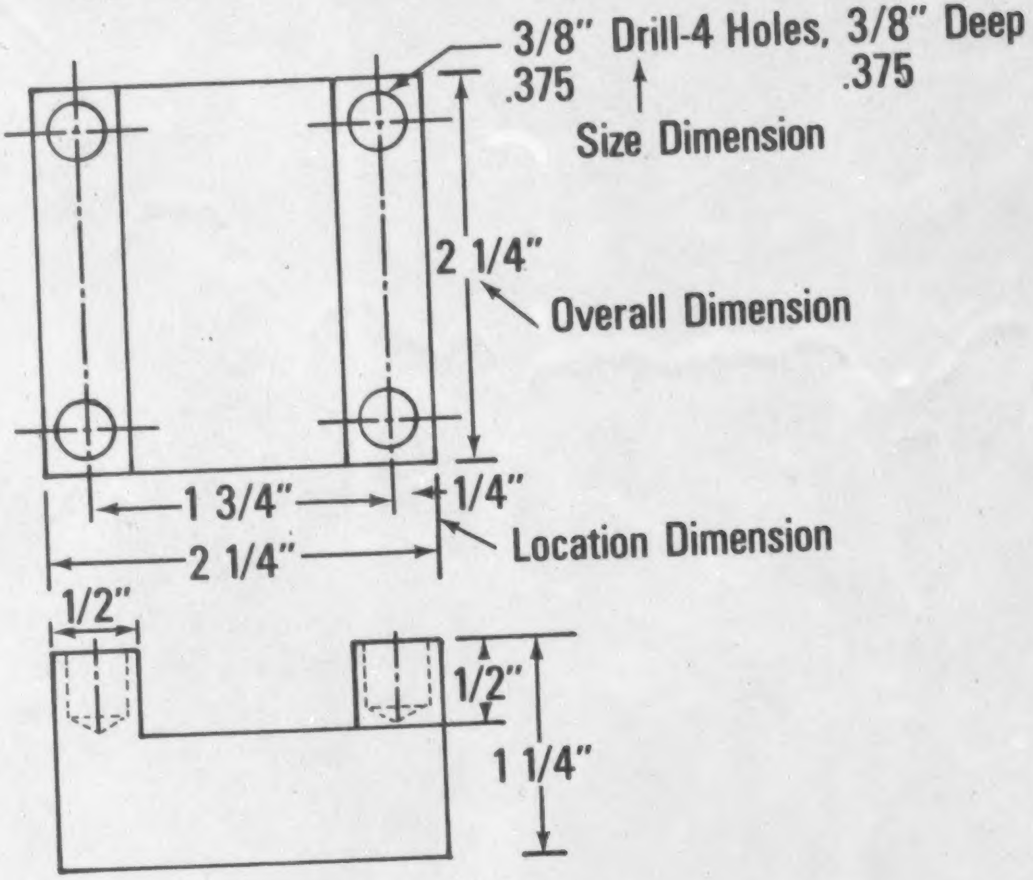
Converting a Pictorial View into a Three-Sided View


Top
Front
End
Top
Front
End

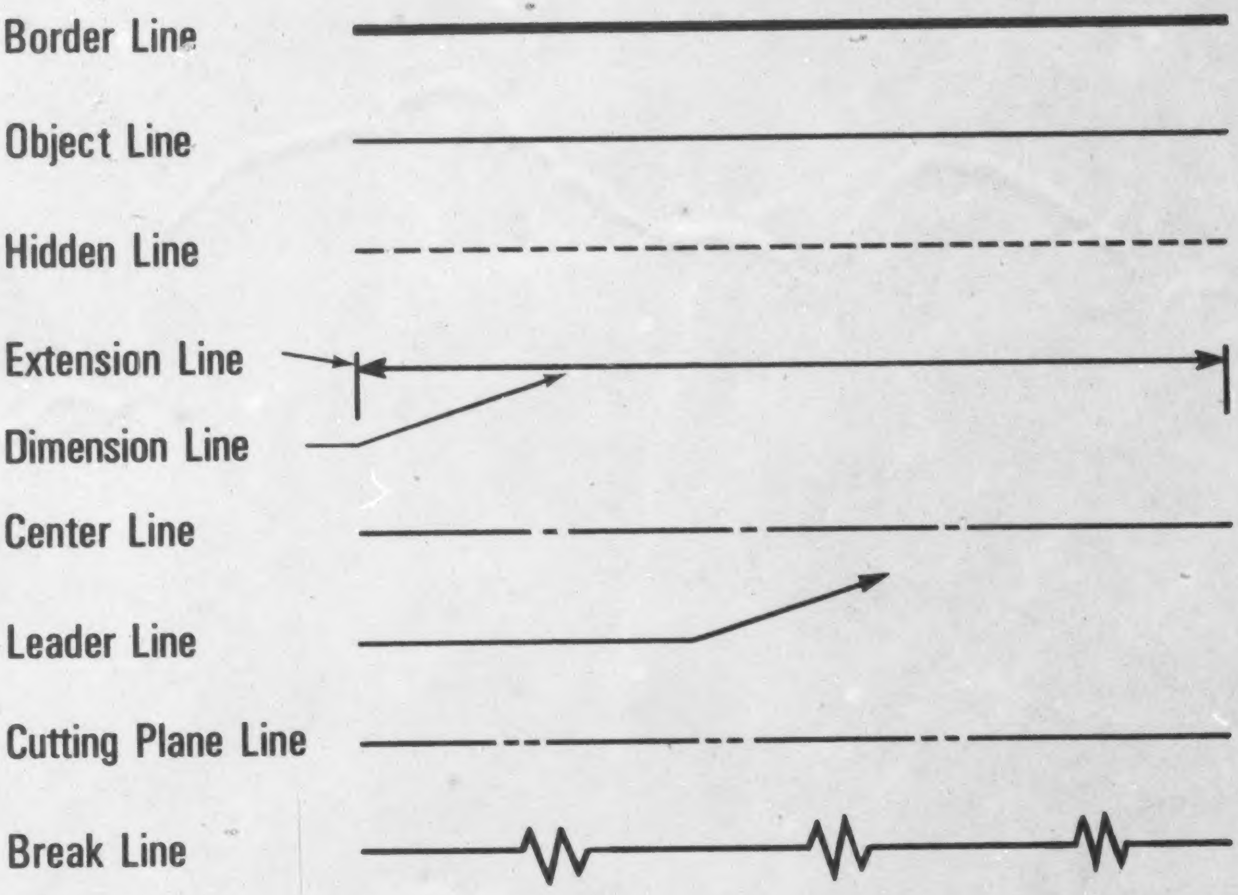
Views


Top
Left Side
Front
Right Side
Rear
Bottom

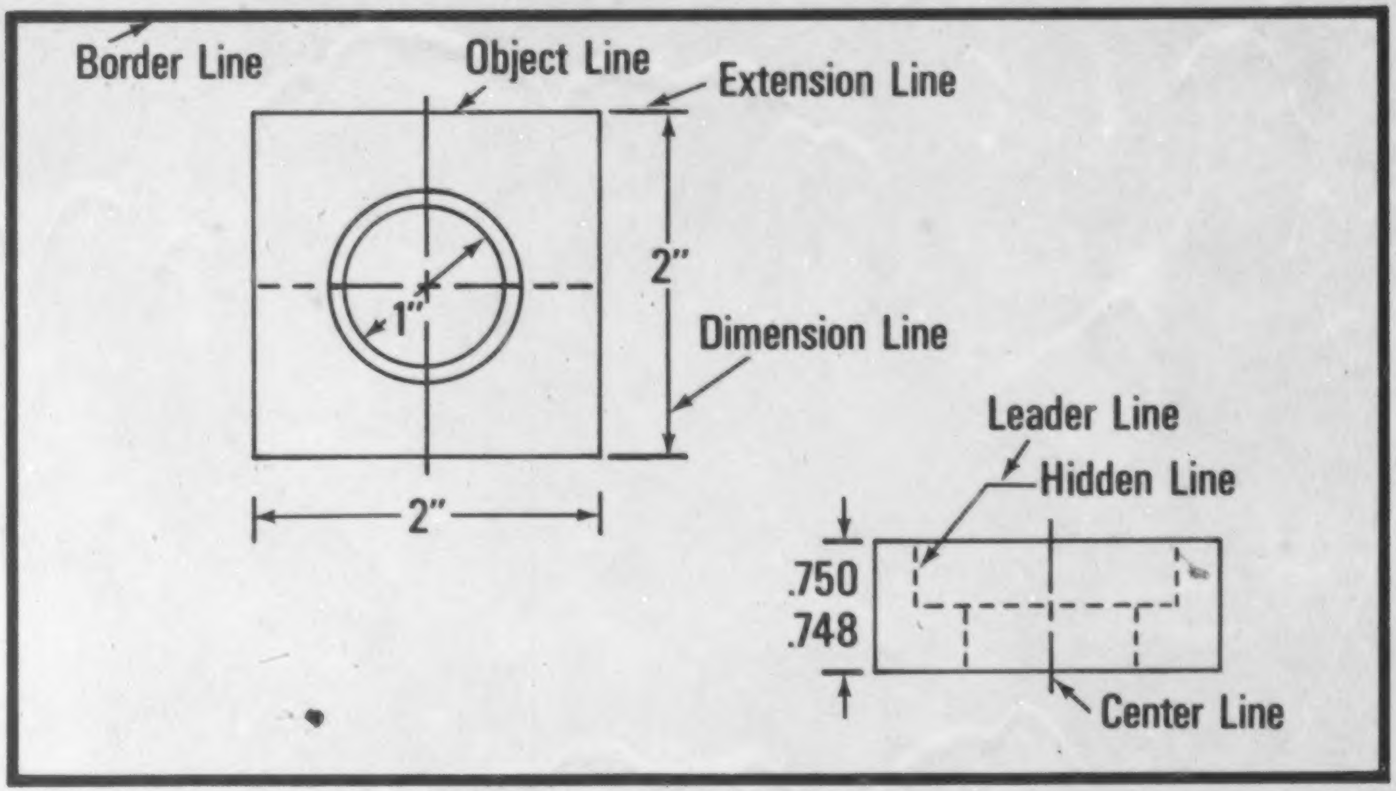
Types of Dimensions on a Blueprint


3/8" Drill-4 Holes, 3/8" Deep
.375
.375
Size Dimension
2 1/4"
Overall Dimension
1 3/4"
1/4"
Location Dimension
2 1/4"
1/2"
1/2"
1 1/4"

Basic Lines Used in Blueprint Reading


Border Line
Object Line
Hidden Line
Extension Line
Dimension Line
Center Line
Leader Line
Cutting Plane Line
Break Line

Use of Lines on a Blueprint

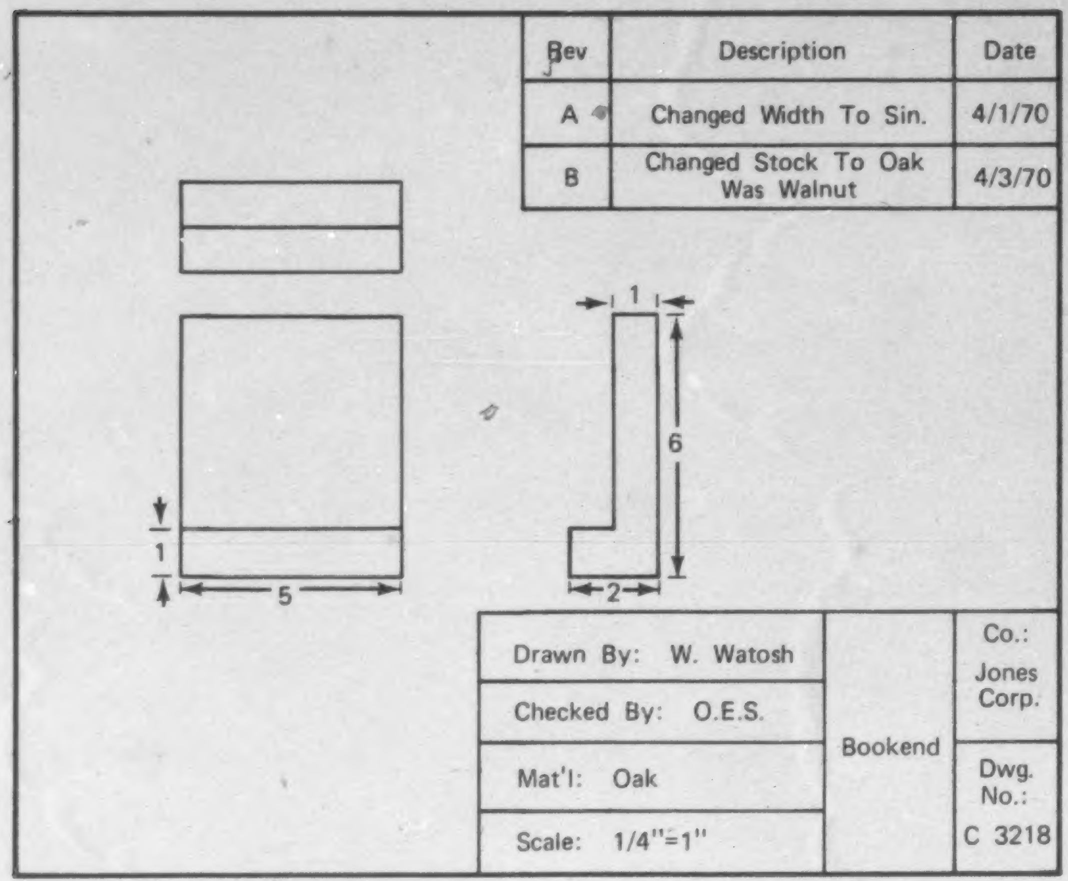

Border Line
Object Line
Extension Line
2"
1"
2"
Dimension Line
Leader Line
Hidden Line
.750
.748
Center Line

BASIC BLUEPRINT READING
UNIT I

ASSIGNMENT SHEET #1--READING AND INTERPRETING BLUEPRINTS

Much practice is necessary for developing skill in reading and interpreting a blueprint. The questions and problems below will provide such practice. Work each of the problems and return to the instructor when completed.

1. Study this blueprint and answer the following questions.



Rev	Description	Date
A	Changed Width To Sin.	4/1/70
B	Changed Stock To Oak Was Walnut	4/3/70

Drawn By: W. Watosh	Bookend	Co.: Jones Corp.
Checked By: O.E.S.		
Mat'l: Oak		Dwg. No.: C 3218
Scale: 1/4"=1"		

a. What company did the drawing? __________

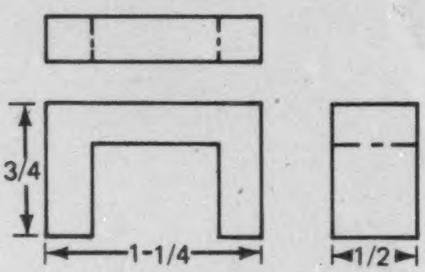
b. What is the name of the object? __________

c. What is the scale of the drawing? __________

d. Who was the draftsman? __________

ASSIGNMENT SHEET #1

2. Give the dimensions of this object.



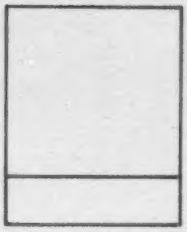
a. Height __________ inches

b. Width __________ inches

c. Depth __________ inches

3. Answer the following questions dealing with views.

   a. Suppose you are standing directly in front of this object. You can not see any other part. What view would you be seeing? __________



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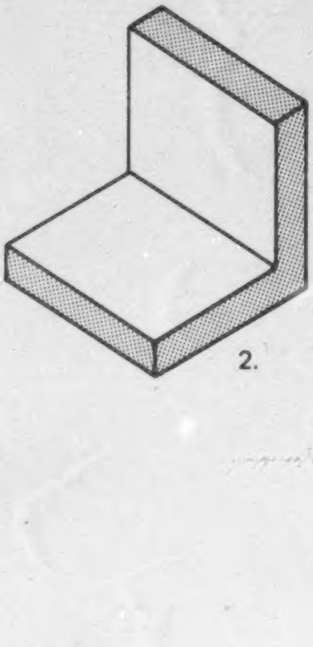
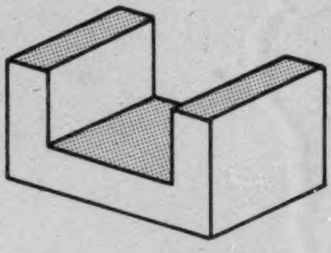


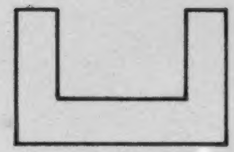
2.

ASSIGNMENT SHEET #1

b. From the following object which would be considered the front view?

____





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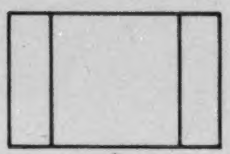

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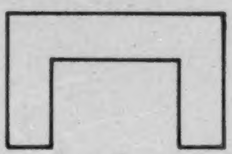
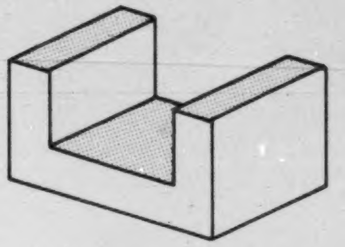
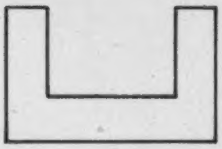


3.

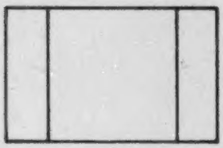
c. From the drawing below which view would be considered the top?

____





1.



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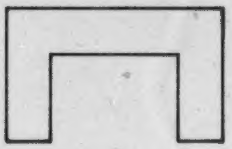
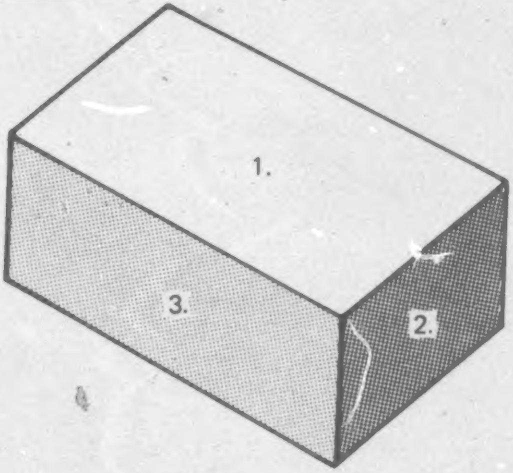


3.

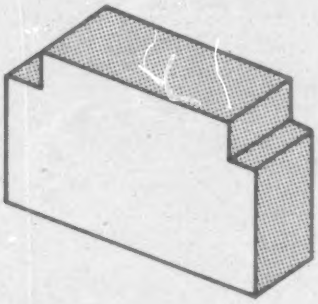
ASSIGNMENT SHEET #1

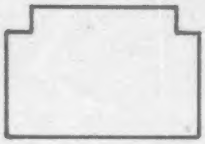
d. Label each part of the drawing.

1. ____________
2. ____________
3. ____________



e. Study this object closely and label each view.

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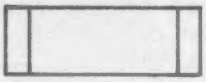
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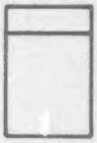

3.

BASIC BLUEPRINT READING
UNIT I

ASSIGNMENT SHEET #2–DRAWING A THREE-VIEW SKETCH

Draw a three-view sketch of a rectangular block using the following dimensions. Be sure to show your dimensions.

1. 10" long by 2" wide by 1" thick

2. 12" long by 1" wide by 1/4" thick

BASIC BLUEPRINT READING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

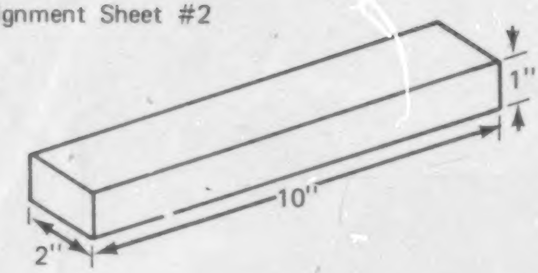
Assignment Sheet #1

1. a. Jones Corporation
   b. Bookend
   c. 1/4" = 1"
   d. W. Watosh
2. a. Height 3/4"
   b. Width 1 1/4"
   c. Depth 1/2"
3. a. 1
   b. 1
   c. 2
   d. 1. Top
      2. End
      3. Front
   e. 1. Front
      2. Top
      3. Right side

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #2

1.



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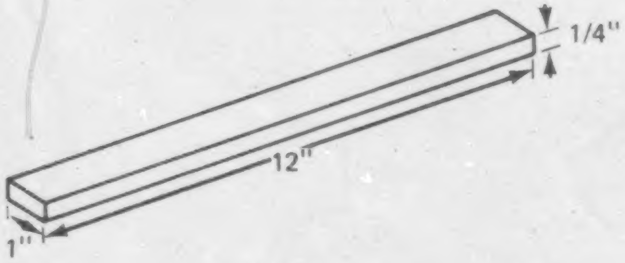


BASIC BLUEPRINT READING
UNIT I

TEST

1. Match the terms on the right with the correct definition.

_____a. The views that illustrate the shape of an object

_____b. A written message conveyed from the draftsman to the workman containing technical information

_____c. The notes and dimensions that tell the size of an object

_____d. A process of illustrating the size of various objects

_____e. A type of dimension that locates a feature on an object

_____f. A type of dimension that tells how large or small an object is

_____g. A drawing illustrating the part of an object one could see if standing directly in front

_____h. An illustration showing three or more sides of an object

_____i. A method of illustrating several views of an object

1. Pictorial view
2. Blueprint
3. Size dimension
4. Dimensions
5. Location dimension
6. Views
7. Size description
8. Orthographic projection
9. Shape description

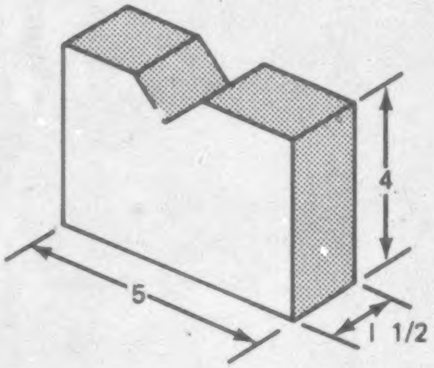
2. Place an "X" in the blank indicating the purpose of a blueprint.

_____a. Provides directions for the draftsman

_____b. Transmits information from draftsman to welder

3. Identify the following information from the blueprint below.

Rev	Description	Date
A	Changed Wood to Grade 1	5/3/70



Drawn By: A. Canabush	V- Block	Co.: Ace Corp.
Checked By: F. Sharer		
Mat'l: Wood		Dwg. No.: D 1974
Scale: 1"=2"		

a. What is the name of the object?________________

b. What is the scale?________________

c. When was the last change made?________________

d. Who was the draftsman?________________

e. What company did the drawing?________________

4. Name the three major views of a pictorial drawing.

a.

b.

c.

5. Identify the following views.

a.________________

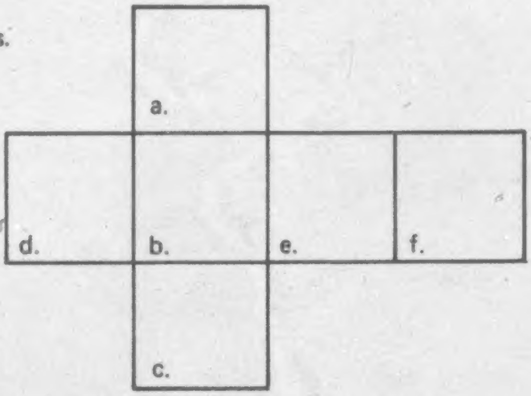
b.________________

c.________________

d.________________

e.________________

f.________________



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6. Name the three basic elements of a blueprint.

   a.

   b.

   c.

7. Name three dimensions to look for on a blueprint.

   a.

   b.

   c.

8. Match the basic types of dimensions with its proper function.

   _____a. Gives information concerning the size of a part

   _____b. Gives information concerning the location of some detail of construction such as a hole

   _____c. Describes a total distance, such as the complete length, width, or thickness of a part

   1. Location dimension
   2. Overall dimension
   3. Size dimension

9. Identify the following lines used in a blueprint.

a.

b.

c.

d.

e.

f.

g.

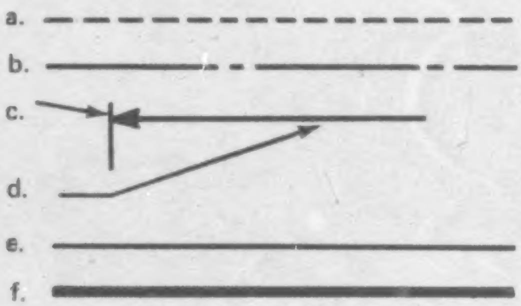
h.

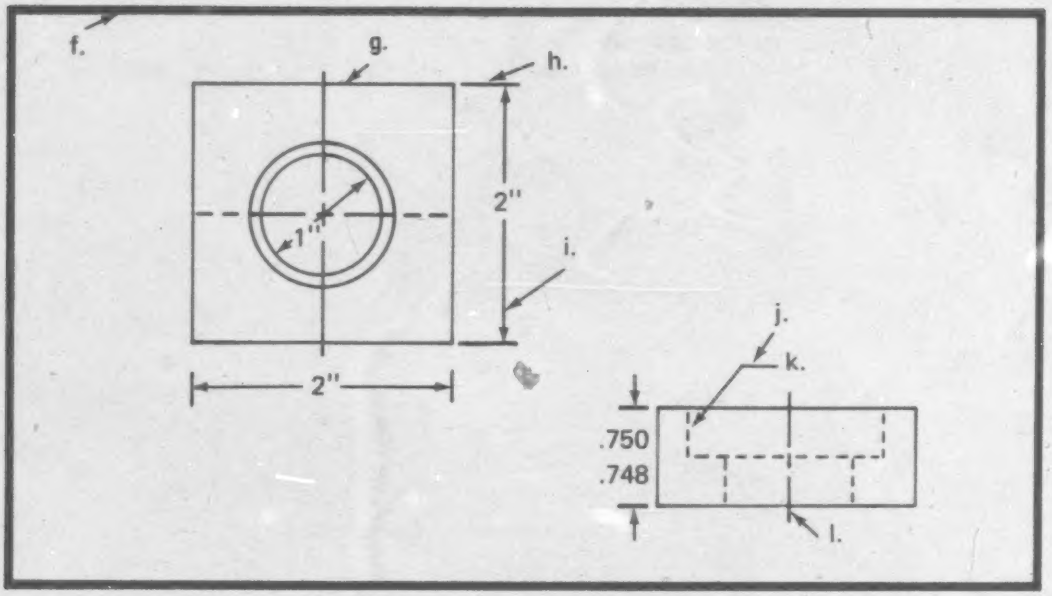
i.

j.

k.

l.




f.
g.
h.
2"
1"
i.
2"
j.
k.
.750
.748
l.

10. Match the following abbreviations with the correct identification.

a. _____Std

b. _____Csk.

c. _____O. D.

d. _____Mal I

e. _____Hex

f. _____Cyl

g. _____Br#

h. _____Stl

i. _____Sq.

j. _____Chfr

k. _____Deg

l. _____Cir

m. _____Fin

n. _____R.

o. _____N. C.

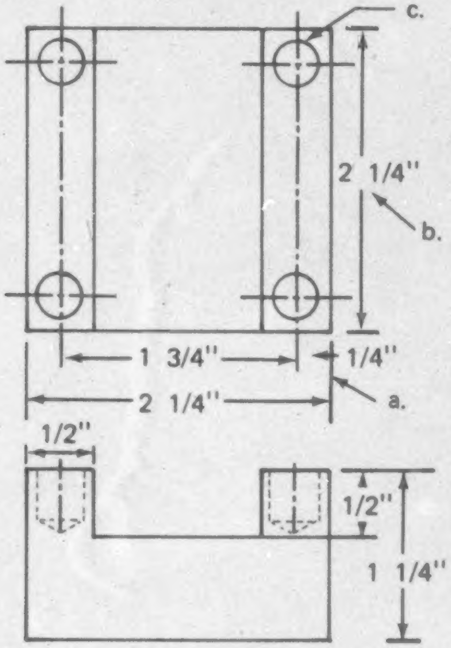
1. Finish
2. Thread
3. Chamfer
4. Bronze, SAE#
5. Steel
6. Brass, SAE#
7. Wrought Iron
8. Galvanized Iron
9. Circular
10. Radius
11. Standard
12. National Coarse
13. Hexagon
14. Degree
15. Square
16. Countersink
17. Outside Diameter
18. Cylinder
19. Malleable Iron
20. Cast Steel

11. Identify the basic types of dimensions found on the blueprint below.

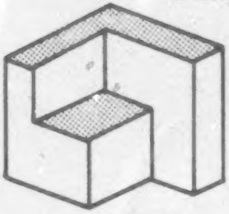
a.

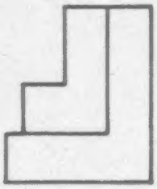
b.

c.

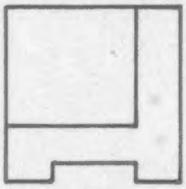


d. From the following illustration which one represents the top view?__________





1.



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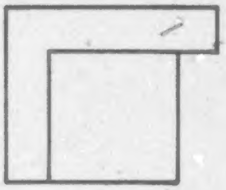
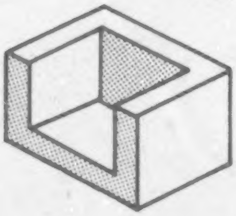
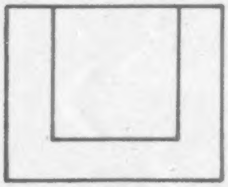


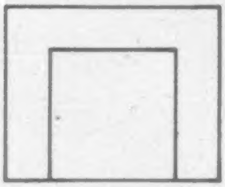
3.

e. Which one of the following illustrations represents the correct front view?__________





1.



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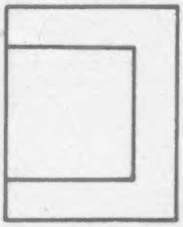


3.

[redacted]

12. Draw a simple three-view sketch of a rectangular block eight inches long by one inch wide by one-half inch thick with correct dimensions.

BASIC BLUEPRINT READING
UNIT I

ANSWERS TO TEST

1. a. 9
   b. 2
   c. 7
   d. 4
   e. 5
   f. 3
   g. 6
   h. 1
   i. 8
2. b
3. a. V-Block
   b. 1"-2"
   c. 5/3/70
   d. A. Canabush
   e. Ace Corp.
4. a. Top
   b. Front
   c. End
5. a. Top
   b. Front
   c. Bottom
   d. Left side
   e. Right side
   f. Rear

6. a. Lines
   b. Dimensions
   c. Notes
7. a. Height
   b. Width
   c. Depth
8. a. 3
   b. 1
   c. 2
9. a. Hidden line
   b. Center line
   c. Extension line
   d. Dimension line
   e. Object line
   f. Border line
   g. Object line
   h. Extension line
   i. Dimension line
   j. Leader line
   k. Hidden line
   l. Center line
10. a. 11
    b. 16
    c. 17
    d. 19
    e. 13
    f. 18
    g. 6

h. 5

i. 15

j. 3

k. 14

l. 9

m. 1

n. 10

o. 12

11. a. Location dimension

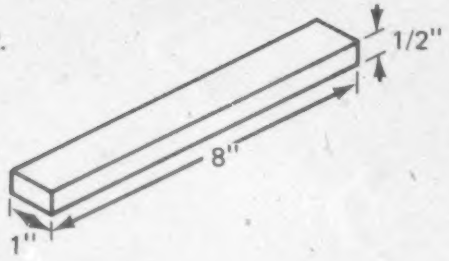
b. Overall dimension

c. Size dimension

d. 3

e. 1

12.



OXYACETYLENE CUTTING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to light, adjust, and turn off an oxyacetylene cutting outfit following the proper order and safety precautions. He should also be able to make ninety degree cuts, bevel cuts, and cut holes in mild steel. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define terms associated with oxyacetylene cutting.
2. Identify the parts of the torch body and cutting attachment.
3. List the purposes of a slag box.
4. List five reasons for poor cuts.
5. List four causes of a backfire.
6. Describe the results when a backfire takes place.
7. Describe the results when a flashback takes place.
8. List in the proper order the steps to follow in case of a flashback.
9. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene cutting.
    b. Turn on, light, and adjust to a neutral flame and turn off oxyacetylene cutting equipment.
    c. Lay out a pattern on metal to be cut with the aid of a straightedge and soapstone.
    d. Make ninety degree cuts in mild steel and restart a cut.
    e. Make a flame beveled cut on mild steel plate.
    f. Cut a hole in mild steel.

OXYACETYLENE CUTTING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in job sheets.

  G. Give test.

II. Student

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit

  A. Objectives

  B. Information sheet

  C. Transparency master: TM 1--Parts of a Torch Body and Cutting Attachment

  D. Job sheets

    1. Job Sheet #1--Set Up Equipment for Oxyacetylene Cutting

    2. Job Sheet #2--Turn On, Light, and Adjust the Cutting Torch to a Neutral Flame and Turn Off the Oxyacetylene Cutting Equipment

3. Job Sheet #3--Lay Out a Pattern on Mild Steel Plate

4. Job Sheet #4--Make Ninety Degree Cuts on Mild Steel and Restart a Cut

5. Job Sheet #5--Make a Flame Beveled Cut on Mild Steel Plate

6. Job Sheet #6--Cut a Hole in Mild Steel

E. Test

F. Answers to test

II. References:

A. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding.* Homewood, Illinois: The Goodheart-Willcox, Company.

B. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: Interstate Printers and Publishers, Inc.

C. *Smith's Short Course for Gas Cutting, Welding, and Brazing.* Minneapolis, Minnesota: Education Department of Smith Welding Equipment, Division of Tescom Corporation.

D. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division.

OXYACETYLENE CUTTING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Flashback--Fire inside torch

(CAUTION: This is a very dangerous condition.)

B. Backfire--Momentary burning back of the flame into the tip

C. Flame cutting--A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

(NOTE: As the metal is oxidized, the preheat flame maintains the temperature necessary to keep the oxidation process going in a narrow zone across the length of the base metal.)

D. Slag box--Metal container with a layer of water or sand to catch hot slag

E. Drag line--Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

F. Kerf--Area where the metal was removed in the form of an oxide during the cutting process

G. Oxide--Term usually applied to rust, corrosion, coating, film, or scale

(NOTE: Oxygen combines with the metal causing oxides.)

H. Oxidizing--Combining oxygen with another substance

Example: A metal is oxidized when the metal is cut

II. Parts of a cutting torch and tip (Transparency 1)

A. Cutting torch

1. Oxygen fitting
2. Acetylene fitting
3. Oxygen torch valve
4. Acetylene torch valve
5. Torch body

INFORMATION SHEET

6. Oxygen cutting lever

7. Oxygen preheat valve

8. Tip nut

9. Slip-in tip

B. Cutting tip

1. Preheat orifice--Heats metal to kindling point (cherry red) of approximately 1600° F.

2. Cutting orifice--Removes oxidized metal

(NOTE: The selection of the correct tip for the job is determined by the thickness of metal, size of tip orifices, and the oxygen cutting pressures. See manufacturer's recommendations.)

III. Purposes of slag box

A. To catch hot slag

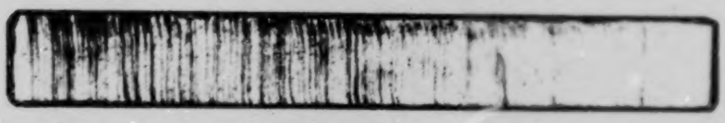
B. To prevent fire

C. To protect clothing

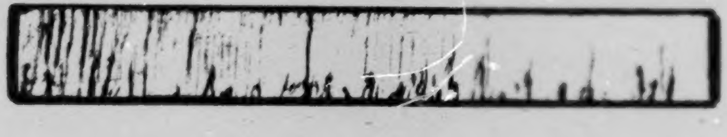
D. To protect welding hoses

IV. Reasons for poor cuts

A. This is a correctly made cut in 1 inch plate; the edge is square and the draglines are essentially vertical and not too pronounced

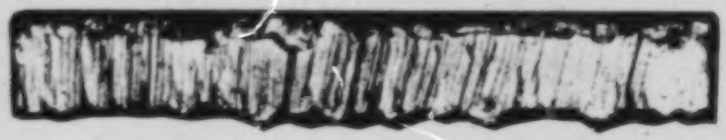


B. Preheat flames were too small for this cut with the result that the cutting speed was too slow, causing bad gouging at the bottom

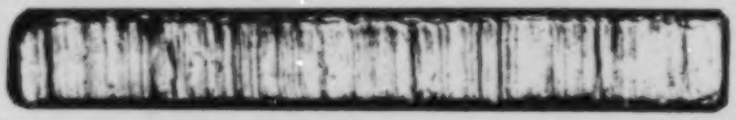


INFORMATION SHEET

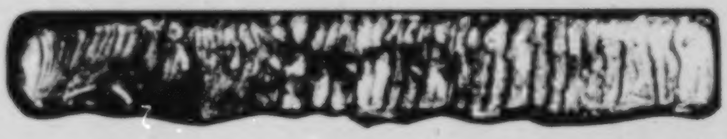
C. Preheat flames were too long with the result that the top surface has melted over, the cut edge is irregular, and there is an excessive amount of adhering slag



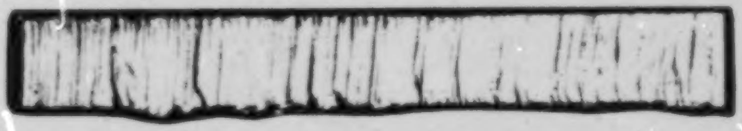
D. Oxygen pressure was too low with the result that the top edge has melted over because of the too slow cutting speed



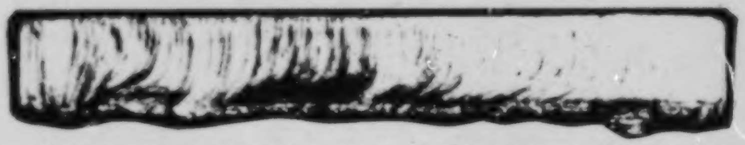
E. Oxygen pressure was too high and the nozzle size too small with the result that the entire control of the cut has been lost



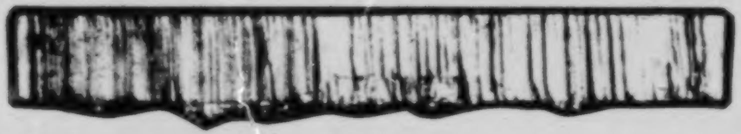
F. Cutting speed was too slow with the result that the irregularities of the draglines are emphasized



G. Cutting speed was too high with the result that there is a pronounced break to the dragline and the cut edge is irregular

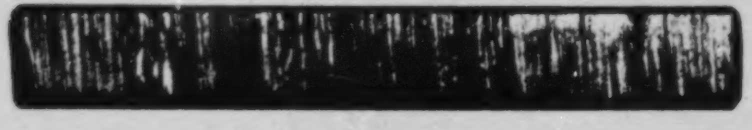


H. Blowpipe travel was unsteady with the result that the cut edge is wavy and irregular



INFORMATION SHEET

I. Cut was lost and not carefully restarted with the result that bad gouges were caused at the restarting point



V. Causes of backfire
  - A. Insufficient acetylene or oxygen pressure
  - B. Loose cutting tip
  - C. Dirty tip
  - D. Overheating of cutting tip
  - E. Bad O-ring in torch body

(NOTE: The above causes should be carefully checked to control backfire.)

VI. Results of a backfire
  - A. Flame burns momentarily back into tip
  - B. A loud snap or pop results
    - 1. Flame may go out
    - 2. Flame may continue to burn in normal manner

VII. Results of flashback
  - A. Fire inside torch
  - B. Disappearance of flame followed by
    - 1. Squealing or hissing noise inside torch
    - 2. Sparks coming from the torch
    - 3. Smoke coming from the torch

VIII. Steps to follow in case of flashback
  - A. Close oxygen preheat valve
  - B. Close oxygen torch valve

INFORMATION SHEET

C. Close acetylene torch valve

D. Release oxygen regulator screw

E. Release acetylene regulator screw

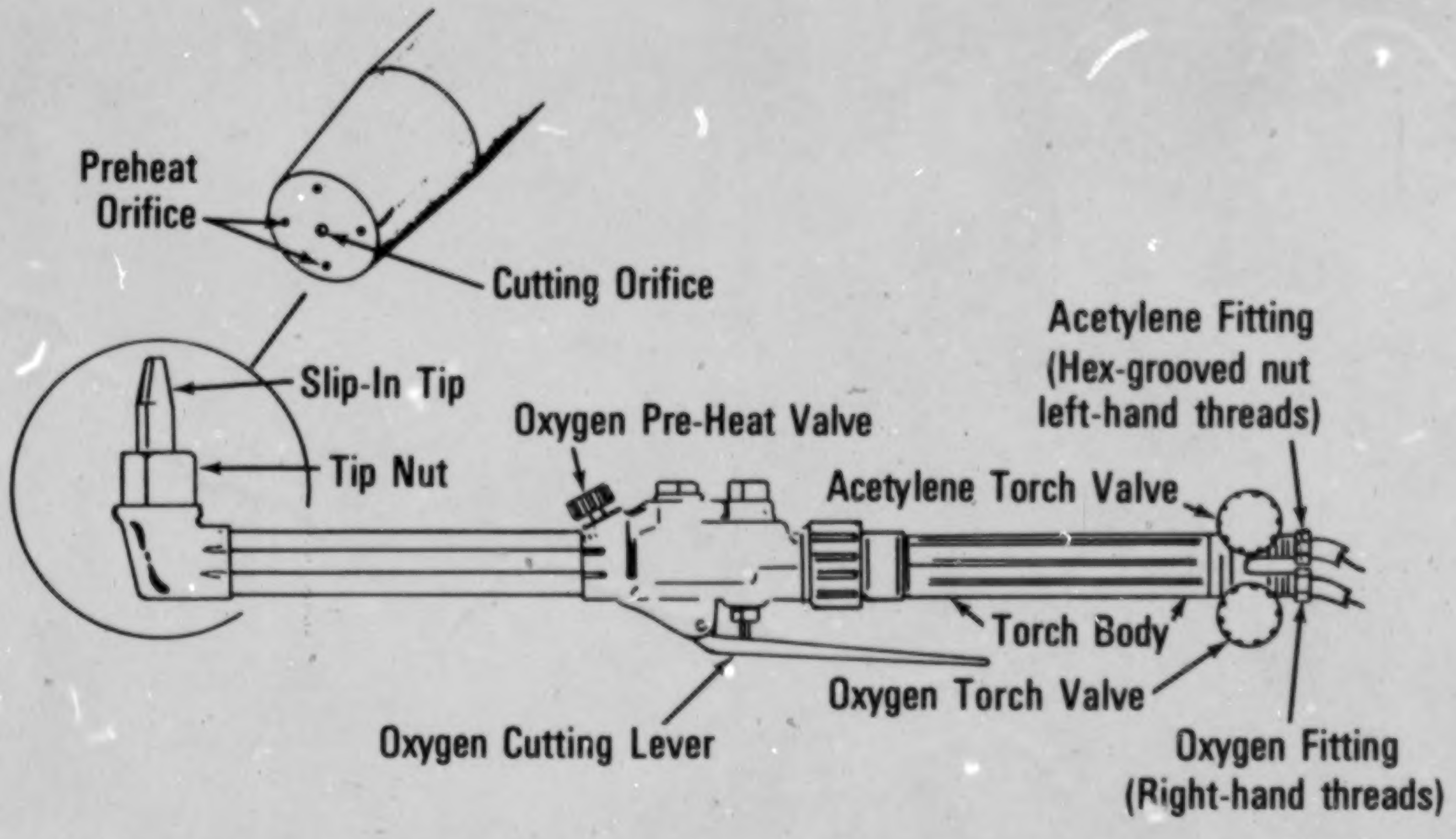
F. Examine acetylene unit

G. Reset regulator pressures

H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen cylinder valve and the acetylene cylinder valve, then notify your instructor.)

Parts of a Torch Body and Cutting Attachment


Preheat Orifice
Cutting Orifice
Slip-In Tip
Tip Nut
Oxygen Pre-Heat Valve
Acetylene Fitting (Hex-grooved nut left-hand threads)
Acetylene Torch Valve
Torch Body
Oxygen Torch Valve
Oxygen Cutting Lever
Oxygen Fitting (Right-hand threads)

OXYACETYLENE CUTTING
UNIT I

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE CUTTING

I. Tools and materials needed

  A. Oxygen cylinder

  B. Acetylene cylinder

  C. Oxygen regulator

  D. Acetylene regulator

  E. Hoses

  F. Wrench

  G. Cylinder holder

  H. Water container

  I. Ivory soap

  J. Clean paint brush

  K. Torch body with tips

II. Procedure

  A. Fasten cylinders in a vertical position

  B. Remove caps from cylinders

  C. Crack valves of each cylinder, then close valves

  D. Connect oxygen regulator to oxygen cylinder

    1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

    2. Slowly turn cylinder valve wide open

  E. Connect acetylene regulator to acetylene cylinder

    1. Turn adjusting screw on regulator counterclockwise until tension on spring is released

    2. Open cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

  F. Connect acetylene hose to acetylene regulator and purge hose

  G. Connect oxygen hose to oxygen regulator and purge hose

JOB SHEET #1

H. Connect torch body to oxygen and acetylene hose and close both valves on torch body

I. Attach cutting attachment to torch body

(NOTE: The size tip is determined by the thickness of metal to be cut and the manufacturer's recommendations.)

J. Close oxygen preheat valve on cutting attachment

K. Turn adjusting screw on oxygen regulator clockwise until working pressure is reached

L. Turn adjusting screw on acetylene regulator clockwise until correct working pressure is reached

M. Test all connections for leaks with Ivory soap suds and water

(NOTE: Apply soap suds with a clean paint brush.)

OXYACETYLENE CUTTING
UNIT I

JOB SHEET #2--TURN ON, LIGHT, AND ADJUST THE CUTTING TORCH TO A NEUTRAL FLAME AND TURN OFF THE OXYACETYLENE CUTTING EQUIPMENT

I. Tools and materials needed

   A. Oxygen cylinder

   B. Acetylene cylinder

   C. Hoses

   D. Oxygen and acetylene regulators

   E. Torch body

   F. Cutting attachment with slip-in tip

   G. Cylinder holder and hose rack

   H. Flint lighter

   I. Wrench

   J. Gloves

   K. Safety goggles

   L. Coveralls or protective clothing

II. Procedure for turning on, lighting, and adjusting the cutting torch to a neutral flame

   A. Check all cylinder, regulator, and torch valves to make sure they are off

   B. Open acetylene cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

   C. Open acetylene valve on torch one turn

JOB SHEET #2

D. Turn adjusting screw on acetylene regulator clockwise until desired pressure is reached*

E. Close acetylene valve on torch

F. Open oxygen cylinder valve all the way

G. Open oxygen torch valve all the way

H. Open oxygen preheat valve on cutting attachment one turn

I. Turn adjusting screw on oxygen regulator clockwise until desired pressure is reached*

J. Close oxygen preheat valve on cutting attachment

K. Open acetylene valve on torch 1/4 turn

L. Light the torch with flint lighter and adjust until smoke on flame clears

M. Open oxygen preheat valve slowly and adjust to a neutral flame

N. Depress the oxygen cutting lever and check to see that a neutral flame is present

(NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured.)

(*NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

III. Procedure for turning off the flame and oxyacetylene unit

A. Close acetylene valve on torch

B. Close oxygen preheat valve

C. Close acetylene cylinder valve

D. Close oxygen cylinder valve

E. Open acetylene valve on torch

(NOTE: When gauges reach 0, close torch valve and release adjusting screw on acetylene regulator by turning counterclockwise.)

[redacted]

JOB SHEET #2

F. Open oxygen preheat valve on torch

(NOTE: When gauges reach 0, close oxygen preheat valve and release adjusting screw on oxygen regulator by turning counterclockwise.)

G. Close oxygen valve on torch

H. Place torch and hose on hanger or brackets provided

OXYACETYLENE CUTTING
UNIT I

JOB SHEET #3--LAY OUT A PATTERN ON MILD STEEL PLATE

I. Tools and materials needed

  A. Square and straightedge

  B. Soapstone

  C. Mild steel plate 1/4" to 1/2" thick, 6" square

  D. Gloves

  E. Safety goggles

  F. Coveralls or protective clothing

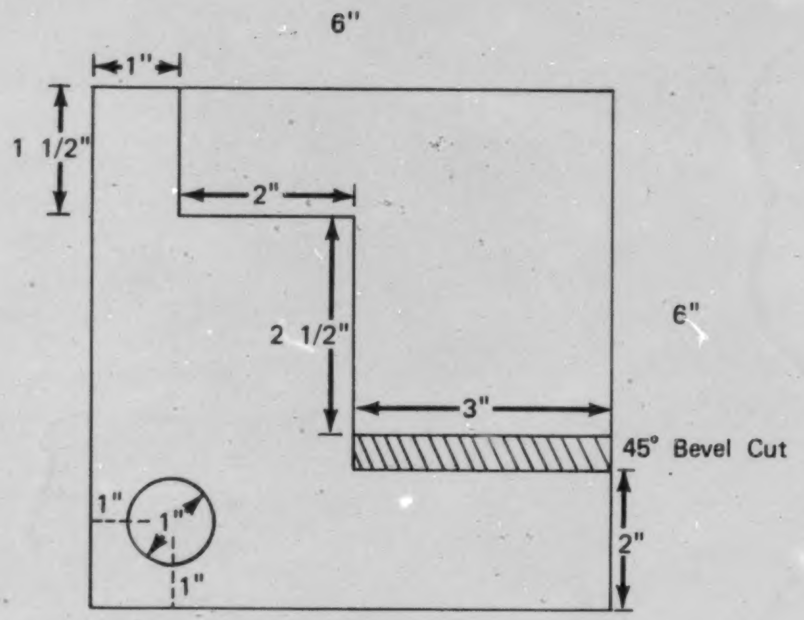
II. Procedure

  A. Select starting point

  B. Measure distances and mark

  C. Complete drawing and turn in to instructor for evaluation (Figure 1)

FIGURE 1



OXYACETYLENE CUTTING
UNIT I

JOB SHEET #4--MAKE NINETY DEGREE CUTS ON MILD STEEL AND RESTART A CUT

I. Tools and materials needed

- A. Cutting outfit with tip assembly
- B. Mild steel plate 1/4" to 1/2" thick, 4" wide or wider, 8" long or longer
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Gloves
- F. Safety goggles
- G. Pliers
- H. Coveralls
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water
- M. Cutting tip

II. Procedure

- A. Mark four parallel lines 2" apart on plate to be cut
- B. Adjust oxygen regulator
- C. Adjust acetylene regulator
- D. Place plate to be cut over slag box
- E. Light torch
- F. Adjust to neutral flame
- G. Assume comfortable position

JOB SHEET #4

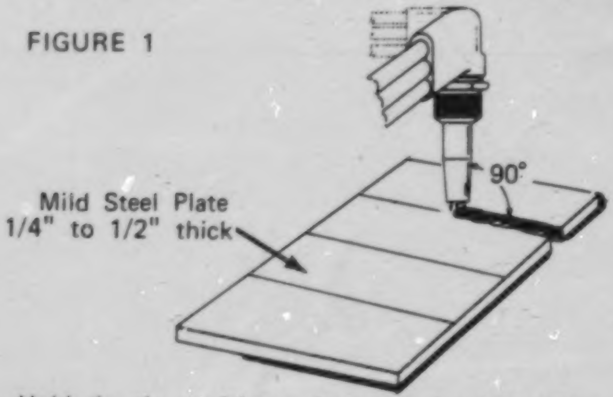
H. Place hoses behind operator

I. Maneuver torch with both hands

J. Hold preheat flame with tip of inner cone 1/16" to 1/8" above top of plate at right edge until red spot appears

K. Depress the oxygen cutting lever, and move from right to left across the plate (for left-handed operators, go from left to right) (Figure 1)

FIGURE 1



L. Hold the tip at right angles to work while cutting with inner cone being 1/16" to 1/8" above work

M. Make 90° cuts until you have developed the proper procedure

N. Cool metal by placing in can of water with the aid of pliers

O. Show samples to instructor for approval and grading

III. Procedure for restarting a cut

A. Release the oxygen cutting lever

B. Preheat edge (only) where cutting action was stopped

C. Slowly depress oxygen cutting lever and continue cut

OXYACETYLENE CUTTING
UNIT I

JOB SHEET #5--MAKE A FLAME BEVELED CUT ON MILD STEEL PLATE

I. Tools and materials needed

   A. Cutting outfit with tip assembly

   B. Mild steel plate 1/4" to 1/2" thick, 4" wide or wider, 8" long or longer

   C. Soapstone with a sharp point or edge

   D. Straightedge

   E. Gloves

   F. Safety goggles

   G. Pliers

   H. Coveralls

   I. Flint lighter

   J. Welding or cutting table

   K. Slag box

   L. Can of water

   M. Cutting tip

II. Procedure

   A. Place one piece of 3/8" to 1/2" plate 2" x 6" on slag box or cutting table

   B. Light and adjust cutting torch to a neutral flame

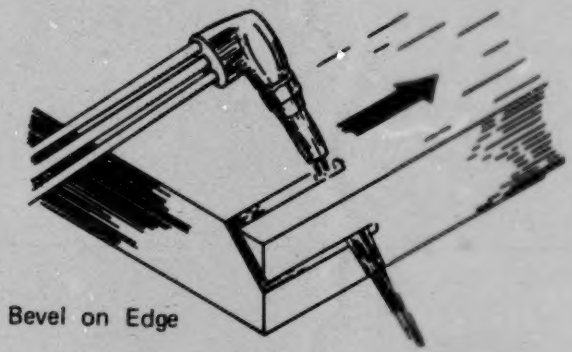
   (NOTE: Oxygen cutting pressures are greater for bevel cuts than 90° cuts.)

   C. Place hoses behind operator

JOB SHEET #5

D. Hold torch with both hands at desired angle to metal as shown (Figure 1)

FIGURE 1



E. Hold preheat flame with tip of inner cone (neutral flame) 1/16" to 1/8" above top of plate until bright red spot appears

F. Depress oxygen cutting lever and proceed across plate with very consistent movement being careful to maintain constant travel speed, torch angle, and flame to work distance

G. Practice until you develop the proper procedure

H. Turn in exercises for instructor's approval and grading

OXYACETYLENE CUTTING
UNIT I

JOB SHEET #6--CUT A HOLE IN MILD STEEL

I. Tools and materials needed

  A. Cutting outfit with tip

  B. Mild steel plates

  C. Soapstone with a sharp point or edge

  D. Straightedge

  E. Gloves

  F. Safety goggles

  G. Pliers

  H. Coveralls

  I. Flint lighter

  J. Welding or cutting table

  K. Slag box

  L. Can of water

II. Procedure

  A. Draw two circles on metal

    1. 1" in diameter, 1" from edge

    2. 1/2" in diameter, 1" from edge

  B. Adjust oxygen regulator

  C. Adjust acetylene regulator

  D. Place metal to be cut over slag box

  E. Light torch

  F. Adjust to neutral flame

  G. Assume comfortable position

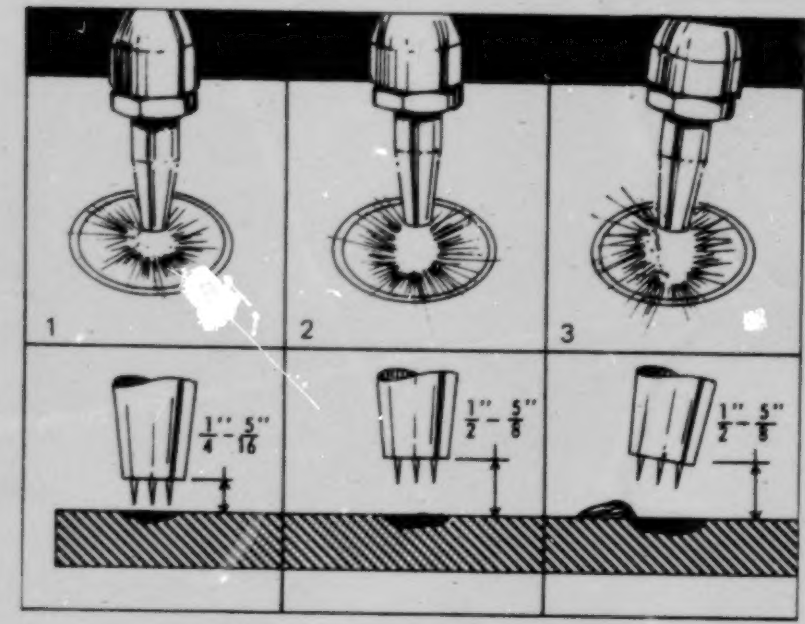
JOB SHEET #6

H. Place hoses behind operator

I. Maneuver torch with both hands

J. Hold tip of inner cone 1/16" to 1/8" above point to be cut until metal turns bright red (Figure 1)

FIGURE 1


1
2
3
$\frac{1}{4}$" - $\frac{5}{16}$"
$\frac{1}{2}$" - $\frac{5}{8}$"
$\frac{1}{2}$" - $\frac{5}{8}$"

1. Tilt torch 15° from vertical position

   (NOTE: This will allow molten metal to be blown away from operator.)

2. Depress oxygen cutting lever slowly moving torch backwards (to the operator's right if right-handed) until cut pierces plate

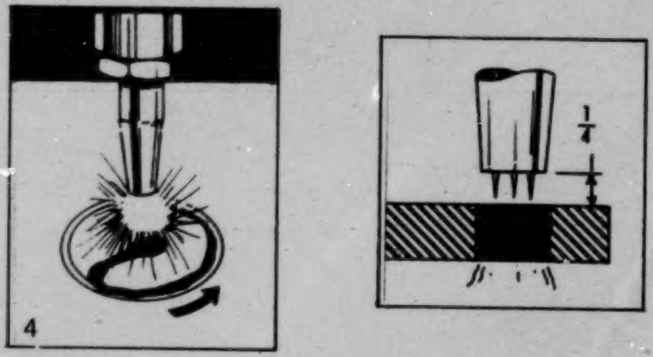
JOB SHEET #6

K. Return cutting torch to vertical position

   1. Raise cutting tip until tip of inner cone is from 1/4" to 1/2" above the plate

   2. Make cut (Figure 2)

FIGURE 2



L. Cut just inside soapstone mark until circular cut is completed

M. Repeat steps K and L until all holes are cut

N. Cool metal by placing in can of water with the aid of pliers

O. Show samples to instructor for approval and grading

OXYACETYLENE CUTTING
UNIT I

TEST

1. Define the following terms.

   a. Flashback--

   b. Backfire--

   c. Flame cutting--

   d. Slag box--

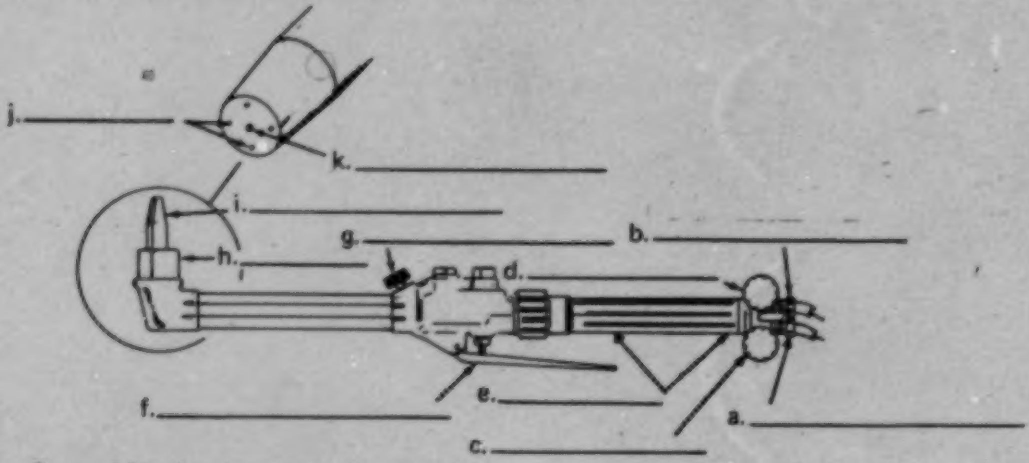
   e Drag line--

   f. Kerf--

   g. Oxide--

   h. Oxidizing--

2. Identify the parts of the torch body and cutting attachment.



3. List the purposes of a slag box.

   a.

   b.

   c.

   d.

4. List five reasons for poor cuts.

   a.

   b.

   c.

   d.

   e.

5. List four causes of a backfire.

   a.

   b.

   c.

   d.

6. Describe the results when a backfire takes place.

7. Describe the results when a flashback takes place.

8. List in the proper order the steps to follow in case of a flashback.

   a.

   b.

   c.

   d.

   e.

   f.

   g.

   h.

9. Demonstrate the ability to:

   a. Set up equipment for oxyacetylene cutting.

   b. Turn on, light, and adjust to a neutral flame and turn off the oxyacetylene cutting equipment.

   c. Lay out a pattern on metal to be cut with the aid of a straightedge and soapstone.

   d. Make 90° cuts on mild steel and restart a cut.

   e. Make a flame beveled cut on mild steel plate.

   f. Cut a hole in mild steel.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE CUTTING
UNIT I

ANSWERS TO TEST

1. a. Flashback--Fire inside torch

   b. Backfire--Momentary burning back of the flame into the tip

   c. Flame cutting--A process by which iron or steel is heated to a temperature where it can be rapidly oxidized by high purity oxygen flowing under pressure through a cutting torch

   d. Slag box--Metal container with a layer of water or sand to catch hot slag

   e. Drag line--Refers to the situation in which the most distant portion of the cutting stream lags behind the stream nearest the cutting tip

   f. Kerf--Area where the metal was removed in the form of an oxide during the cutting process

   g. Oxide--Term usually applied to rust, corrosion, coating, film, or scale

   h. Oxidizing--Combining oxygen with another substance

2. a. Oxygen fitting

   b. Acetylene fitting

   c. Oxygen torch valve

   d. Acetylene torch valve

   e. Torch body

   f. Oxygen cutting lever

   g. Oxygen preheat valve

   h. Tip nut

   i. Slip-in tip

   j. Preheat orifice

   k. Cutting orifice

3. a. To catch hot slag

   b. To prevent fire

- c. To protect clothing
- d. To protect welding hoses

4. Any five of the following
   - a. Preheat flames too small causing cutting speed to be too slow
   - b. Preheat flames too long
   - c. Oxygen pressure too low
   - d. Oxygen pressure too high and nozzle size too small
   - e. Cutting speed too slow
   - f. Cutting speed too high
   - g. Blowpipe travel unsteady
   - h. Cut lost and not carefully restarted
5. Any four of the following
   - a. Insufficient acetylene or oxygen pressure
   - b. Loose cutting tip
   - c. Dirty tip
   - d. Overheating of cutting tip
   - e. Bad O-ring in torch body
6. Description should include:
   - a. Flame burns momentarily back into tip
   - b. A loud snap or pop results
     - 1. Flame may go out
     - 2. Flame may continue to burn in normal manner
7. Description should include:
   - a. Fire inside torch
   - b. Disappearance of flame followed by
     - 1) Squealing or hissing noise inside torch
     - 2) Sparks coming from torch
     - 3) Smoke coming from torch

8.
   a. Close oxygen preheat valve
   b. Close oxygen torch valve
   c. Close acetylene torch valve
   d. Release oxygen regulator screw
   e. Release acetylene regulator screw
   f. Examine acetylene unit
   g. Reset regulator pressures
   h. Light torch

9. Performance skills will be evaluated to the satisfaction of the instructor.

OXYACETYLENE FUSION WELDING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to properly set up, light, adjust, and turn off oxyacetylene welding equipment following the proper order and safety precautions. In addition, he should be able to select the proper size welding tip according to manufacturer's recommendations and to choose the correct filler rod for a welding job. He should be able to demonstrate the ability to carry a puddle with or without a filler rod. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define six terms associated with oxyacetylene fusion welding.
2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.
3. Identify oxyacetylene welding equipment.
4. Name five factors that determine fusion weld quality.
5. List five properties of a good weld.
6. Name two factors that determine tip size in oxyacetylene fusion welding.
7. List two factors that determine the type of filler rod to use in oxyacetylene fusion welding.
8. Describe the purpose of the filler rod.
9. Identify three types of oxyacetylene fusion welding flames.
10. Demonstrate the ability to:
    a. Set up equipment for oxyacetylene welding.
    b. Turn on, light, adjust, and turn off the oxyacetylene welding equipment.
    c. Construct a corner weld without filler rod.
    d. Lay beads on gauge metal with and without filler rod.
    e. Weld butt joints with filler rod.

OXYACETYLENE FUSION WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives.

  E. Discuss information sheet.

  F. Demonstrate and discuss procedures outlined in the job sheets.

  G. Give test.

  (NOTE: The instructor may want to secure film from Curriculum and Materials Center on Fusion Welding to show to class.)

II. Students:

  A. Read objectives.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--Oxyacetylene Welding Equipment

    2. TM 2--Welding Torches

    3. TM 3--Welding Regulators

    4. TM 4--Oxyacetylene Fusion Welding Flames

D. Job sheets

1. Job Sheet #1--Set Up Equipment for Oxyacetylene Welding
2. Job Sheet #2--Turn On, Light, Adjust, and Turn Off Oxyacetylene Welding Equipment
3. Job Sheet #3--Construct a Corner Weld Without a Filler Rod
4. Job Sheet #4--Lay Beads On Gauge Metal Without Filler Rod
5. Job Sheet #5--Lay Beads On Gauge Metal With Filler Rod
6. Job Sheet #6--Weld Butt Joints With Filler Rod

E. Test

F. Answers to test

II. References:

A. *Smith's Instructor's Manual for a Basic Course in Oxyacetylene Brazing, Cutting and Welding (Form 424).* Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.

B. *Instructor's Answer Key (Form 429).* For use with *Smith's Instructor's Manual (Form 424).* Minneapolis, Minnesota: Smith Welding Equipment, Division of Tescom Corporation.

C. Phipps, Lloyd J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

D. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding.* Homewood, Illinois: Goodheart-Willcox Co., Inc.

E. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division.

OXYACETYLENE FUSION WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Fusion welding--Joining pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   B. Penetration--Distance from the original surface of the base metal to that point at which fusion ceases

   C. Base metal--Metal being welded

   D. Alloy--A mixture with metallic properties composed of two or more elements of which one is a metal

   E. Inner cone--The inner white part of the neutral flame

   F. Tack weld--A short weld used for temporarily holding material in place

II. Safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment

   A. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   (NOTE: Acetylene gas is in a liquid state in the cylinder and should be used in vertical position in order that acetone will not be withdrawn.)

   B. Blow out cylinder valves (crack cylinder valve for a second before attaching regulators) in order to remove dust and dirt that may damage regulator

   C. Release pressure adjusting screw on regulator before opening cylinder valve in order to prevent damage to regulators and and possible injury to operator

   D. Stand to the side of regulators keeping the cylinder valve between operator and regulator when opening cylinder valves

   E. Open cylinder valves slowly

   F. Do not use acetylene (in free state) at pressures higher than 15 psi

   (NOTE: Acetylene becomes unstable at pressures above 15 psi and becomes highly explosive.)

   G. Purge oxygen and acetylene passages (individually) before lighting torch

   H. Light acetylene before opening oxygen torch valve

INFORMATION SHEET

I. Never use oil or grease on regulators, torches, or fittings

(NOTE: Oil or grease and oxygen have a very great affinity for one another and will unite with explosive violence.)

J. Do not use oxygen as a substitute for compressed air

K. Use safety goggles, gloves, and protective clothing

L. Have CO_2 or dry powder type fire extinguisher available

M. Test connections for leaks with Ivory soap suds, paint brush, and water

N. Avoid lighting torch or cutting near combustible materials

O. Never open the acetylene cylinder valve more than 1/2-3/4 turns

P. Always operate torch in a well-ventilated area

Q. Never cut on containers that have been used for combustible materials

R. Avoid breathing toxic fumes when cutting

Example: Galvanized metal

S. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

T. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on the equipment

U. Turn acetylene torch valve off first in order that the flame will go out immediately

V. Keep hands, gloves, and clothing free from oil and grease

W. Never cut or weld too close to concrete

X. Always weld or cut at least five feet from cylinders

Y. Always protect hoses from hot metal, rupture, or mechanical damage

Z. Always light torch with a friction lighter

AA. Never leave a burning torch unattended

III. Oxyacetylene welding equipment (Transparencies 1, 2, and 3)

A. Acetylene cylinder

INFORMATION SHEET

- B. Acetylene cylinder valve
- C. Acetylene fittings
- D. Acetylene regulator
- E. Oxygen cylinder
- F. Oxygen cylinder valve
- G. Oxygen fittings
- H. Oxygen regulators
- I. Oxygen torch valve
- J. Welding torch body
- K. Acetylene torch valve
- L. Welding tip
- M. Welding goggles with #5 shade lens
- N. Welding gloves
- O. Safety chain
- P. Flint lighter
- Q. Cylinder truck

IV. Factors determining fusion weld quality

- A. Proper flame adjustment
- B. Angle of tip
- C. Distance from work
- D. Speed of travel
- E. Movement of tip

V. Properties of a good weld

- A. Consistent width
- B. Straightness
- C. Slightly crowned
- D. Fused into base metal
- E. Clean appearance

INFORMATION SHEET

VI. Factors determining tip size selection

  A. Metal thickness

  B. Size of welding rod

  (NOTE: Always use manufacturer's recommendations on tip size.)

VII. Factors determining rod selection

  A. Rod with similar properties as base metal

  B. Thickness of metal

  (NOTE: A general rule is to use a rod with a diameter equal to the thickness of the base metal.)

VIII. Purpose of filler rod--To add strength to weld or joint

IX. Oxyacetylene fusion welding flames (Transparency 4)

  A. Carburizing flame

    1. Contains excess of acetylene

    (NOTE: An acetylene feather is visible on the inner cone.)

    2. Recommended flame for cutting cast iron

    3. Introduces carbon into weld, causing hardening of the metal

    (NOTE: The resultant weld is weak.)

  B. Neutral flame

    1. Burns equal amounts of oxygen and acetylene

    2. Identified by clear, well-defined white cone

    3. Temperature 5950°

  C. Oxidizing flame

    1. Burns excess of oxygen

    2. Identified by short white inner cone

    3. Oxidizes the metal causing it to harden and become brittle

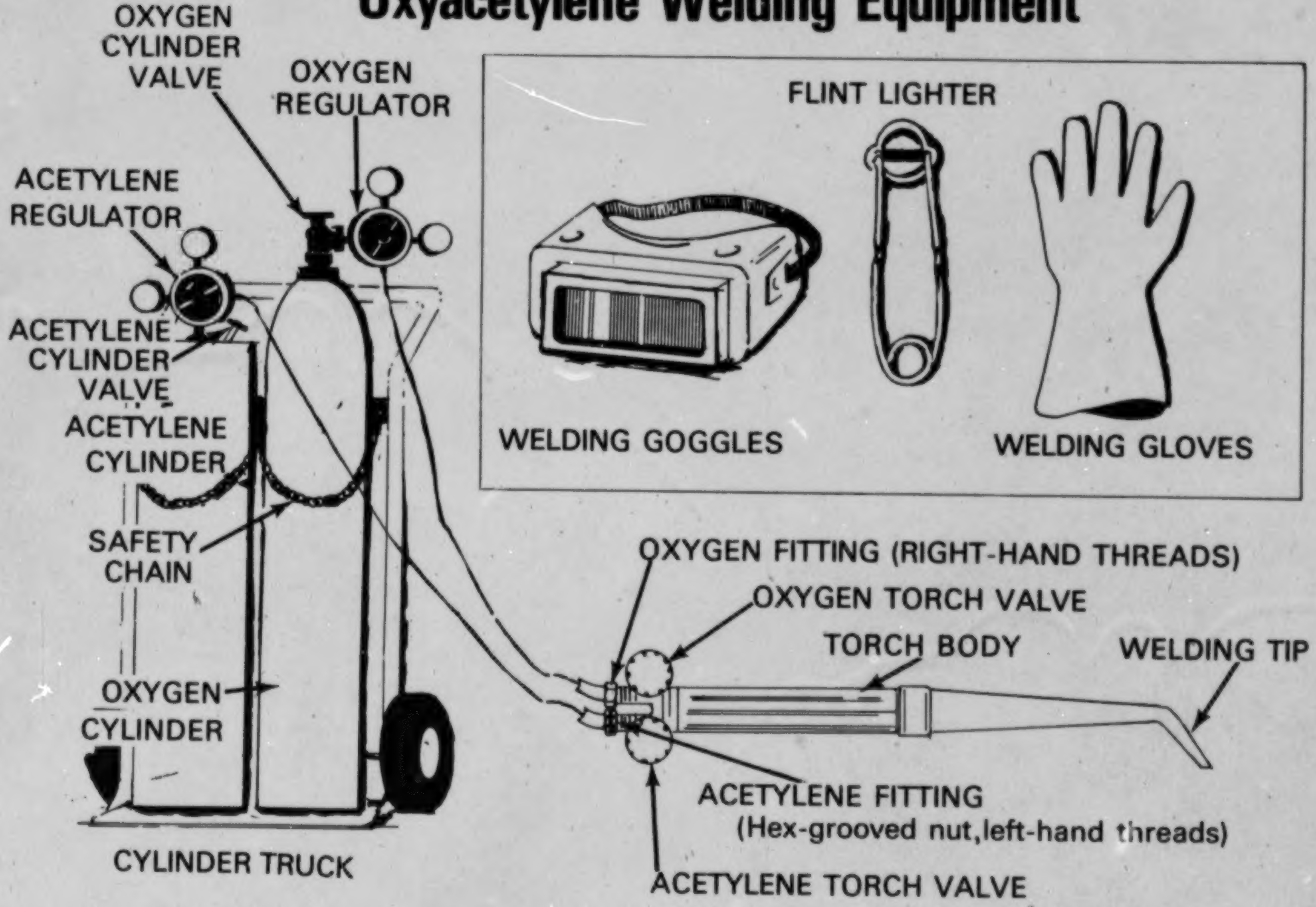
    4. Not recommended for average cutting

INFORMATION SHEET

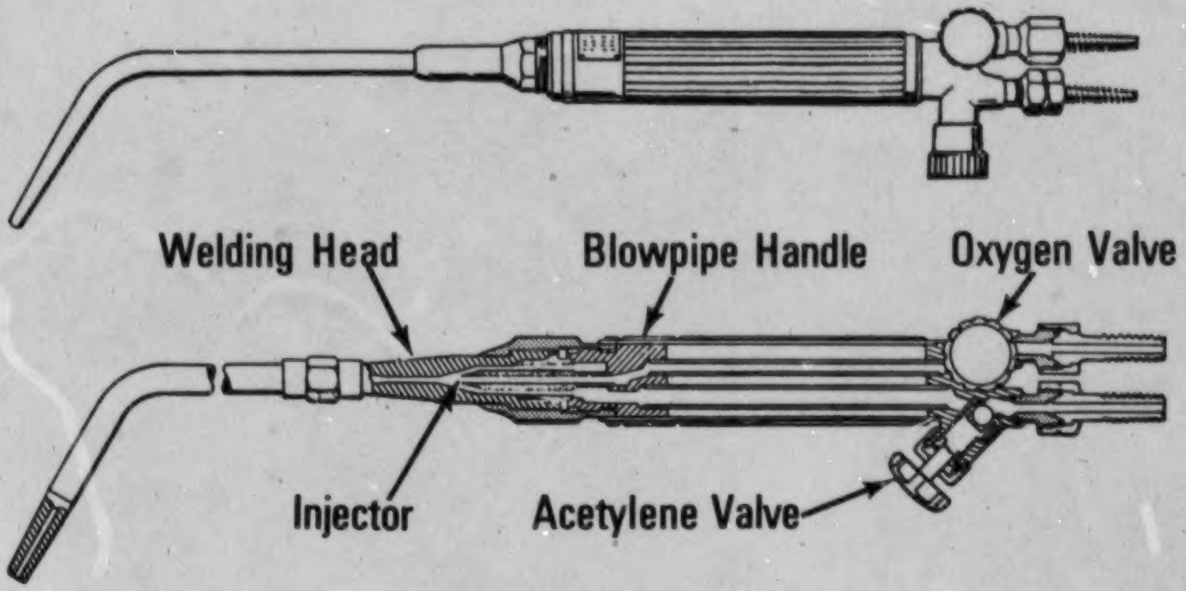
5. Is the hottest flame

6. A slightly oxidizing flame is recommended for brazing

Oxyacetylene Welding Equipment

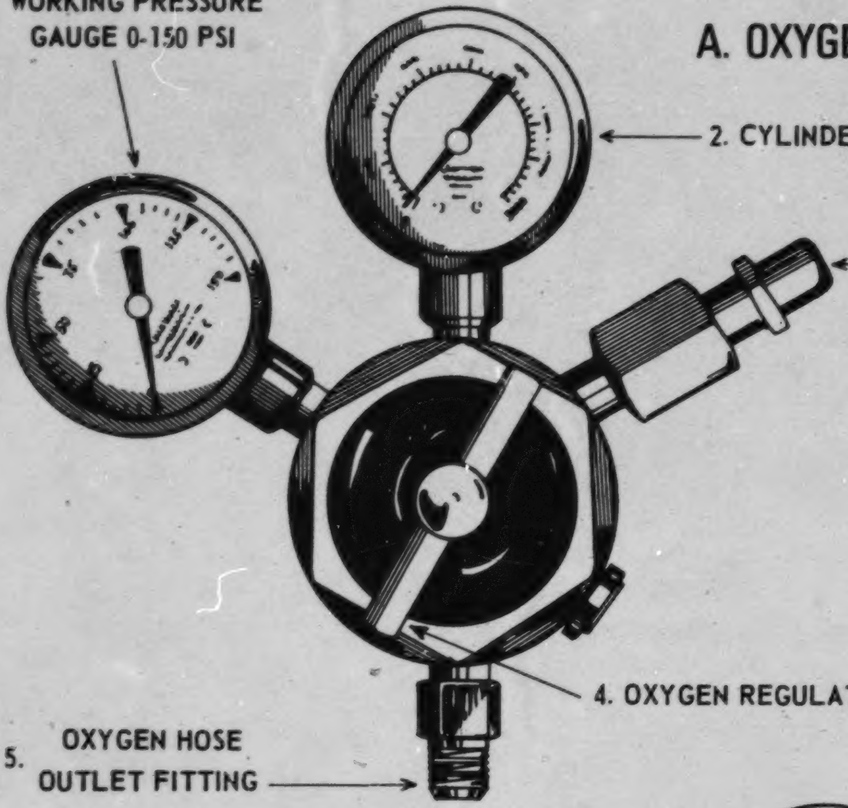

OXYGEN CYLINDER VALVE
OXYGEN REGULATOR
ACETYLENE REGULATOR
ACETYLENE CYLINDER VALVE
ACETYLENE CYLINDER
SAFETY CHAIN
OXYGEN CYLINDER
CYLINDER TRUCK
FLINT LIGHTER
WELDING GOGGLES
WELDING GLOVES
OXYGEN FITTING (RIGHT-HAND THREADS)
OXYGEN TORCH VALVE
TORCH BODY
WELDING TIP
ACETYLENE FITTING
(Hex-grooved nut,left-hand threads)
ACETYLENE TORCH VALVE

Welding Torches

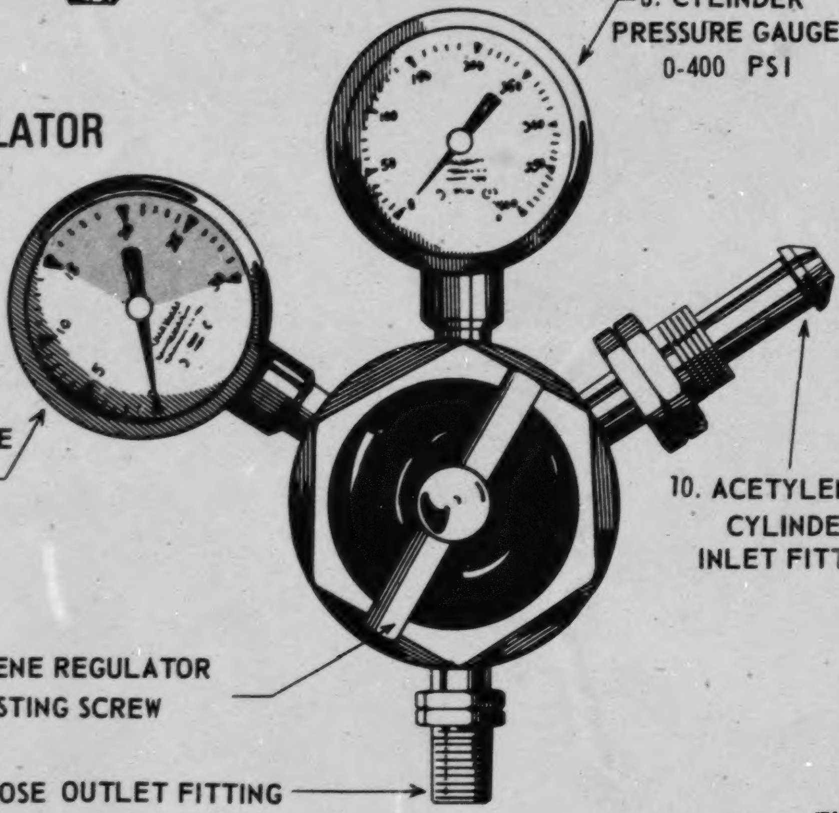

Welding Head
Blowpipe Handle
Oxygen Valve
Injector
Acetylene Valve

Welding Regulators

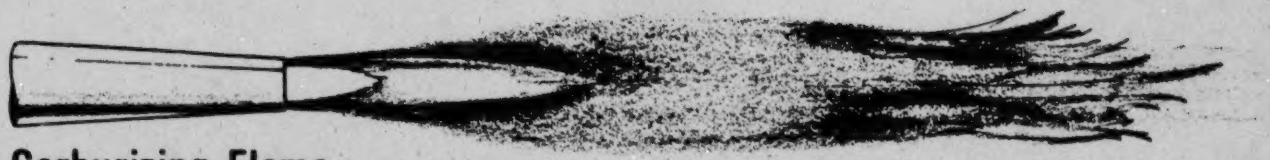
A. OXYGEN REGULATOR GAUGES


1. WORKING PRESSURE GAUGE 0-150 PSI
2. CYLINDER PRESSURE GAUGE 0 to 3000 PSI
3. OXYGEN CYLINDER INLET FITTING
4. OXYGEN REGULATOR ADJUSTING SCREW
5. OXYGEN HOSE OUTLET FITTING

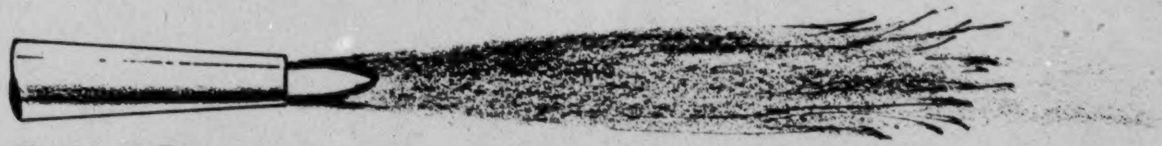
B. ACETYLENE REGULATOR


6. CYLINDER PRESSURE GAUGE 0-400 PSI
7. WORKING PRESSURE GAUGE 0 TO 30 PSI
8. ACETYLENE REGULATOR ADJUSTING SCREW
9. ACETYLENE HOSE OUTLET FITTING
10. ACETYLENE CYLINDER INLET FITTING

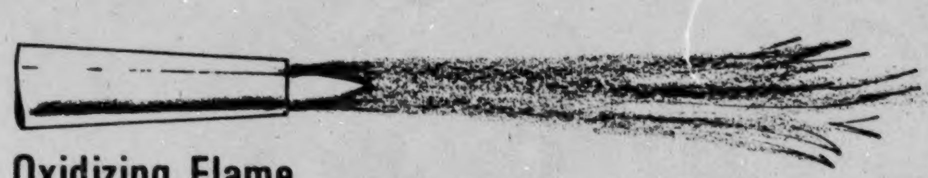
Oxyacetylene Fusion Welding Flames



Carburizing Flame



Neutral Flame



Oxidizing Flame

OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #1--SET UP EQUIPMENT FOR OXYACETYLENE WELDING

I. Procedure for setting up equipment

   A. Fasten cylinders in a vertical position

   B. Remove caps from cylinders

   C. Crack valves of each cylinder then close valves

   D. Connect oxygen regulator to oxygen cylinder

      1. Turn pressure adjusting screw on regulator counterclockwise until tension on spring is released

      2. Slowly open cylinder and tighten in open position

   E. Connect acetylene regulator to acetylene cylinder

      1. Turn pressure adjusting screw on regulator counterclockwise until tension on spring is released

      2. Open cylinder valve 1/2 to 3/4 of a turn (never more than 1 1/2 turns)

   F. Connect acetylene hose (red) to acetylene regulator and purge hose

      (NOTE: All acetylene fittings have a grooved nut to indicate left-hand threads.)

   G. Connect oxygen hose (green) to oxygen regulator and purge hose

      (NOTE: All oxygen fittings have right-hand threads.)

   H. Connect torch body to oxygen and acetylene hose and close both valves on torch body

   I. Attach welding tip to torch body

      (NOTE: Size of tip is determined by thickness of metal to be welded. Use manufacturer's recommendations for tip size and working pressures.)

   J. Turn pressure adjusting screw on oxygen regulator clockwise until working pressure is reached

   K. Turn pressure adjusting screw on acetylene regulator clockwise until working pressure is reached

   L. Test all connections for leaks with Ivory soap suds and water

      (NOTE: Apply soap suds with a clean paint brush.)

OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #2--TURN ON, LIGHT, ADJUST, AND TURN OFF OXYACETYLENE WELDING EQUIPMENT

I. Procedure for turning on and lighting

   A. Check all cylinder, regulator, and torch valves to make sure they are turned off

   B. Open acetylene cylinder valve 1/2 to 3/4 of a turn

   (CAUTION: Never open more than 1 1/2 turns.)

   C. To purge line, open acetylene valve on torch one turn

   *D. Turn acetylene regulator pressure adjusting screw clockwise until desired working pressure is reached

   E. Close acetylene valve on torch

   F. Open oxygen cylinder valve all the way and tighten in open position

   G. Open oxygen torch valve one turn

   *H. Turn oxygen regulator pressure adjusting screw clockwise until desired pressure is reached

   I. Close oxygen valve on torch

   J. Open acetylene valve on torch 1/4 turn

   K. Light the torch with flint lighter and adjust until smoke on flame clears

   L. Open oxygen torch valve and adjust to a neutral flame with a tiny trace of feather on the inner cone

   (*NOTE: The working pressure is determined by the size of the tip.)

II. Procedure for adjusting welding torch for the three types of flames

   A. Start with a neutral flame

   B. To produce a carburizing flame, reduce the supply of oxygen by slowly closing the oxygen torch valve until an excess acetylene feather is produced

   C. To produce an oxidizing flame, increase the supply of oxygen by slowly opening the oxygen torch valve until a short, white inner cone is produced

JOB SHEET #2

III. Procedure for turning off the torch and oxyacetylene welding unit

A. Close acetylene torch valve

B. Close oxygen torch valve

C. Close acetylene cylinder valve

D. Close oxygen cylinder valve

E. Open acetylene torch valve

(NOTE: When gauges reach 0, release acetylene regulator pressure adjusting screw and close torch valve.)

F. Open oxygen valve on torch

(NOTE: When gauges reach 0, release oxygen regulator pressure adjusting screw and close torch valve.)

G. Place torch and hoses on hanger or brackets

OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #3--CONSTRUCT A CORNER WELD WITHOUT A FILLER ROD

I. Tools, materials, and equipment needed

- A. Oxyacetylene welding unit
- B. Welding tip (according to manufacturer's recommendations)
- C. Gloves
- D. Goggles
- E. Pliers
- F. Wire brush
- G. Flint lighter
- H. Fire brick
- I. Two pieces of mild steel strips, 16 gauge 1 1/4" by 6"

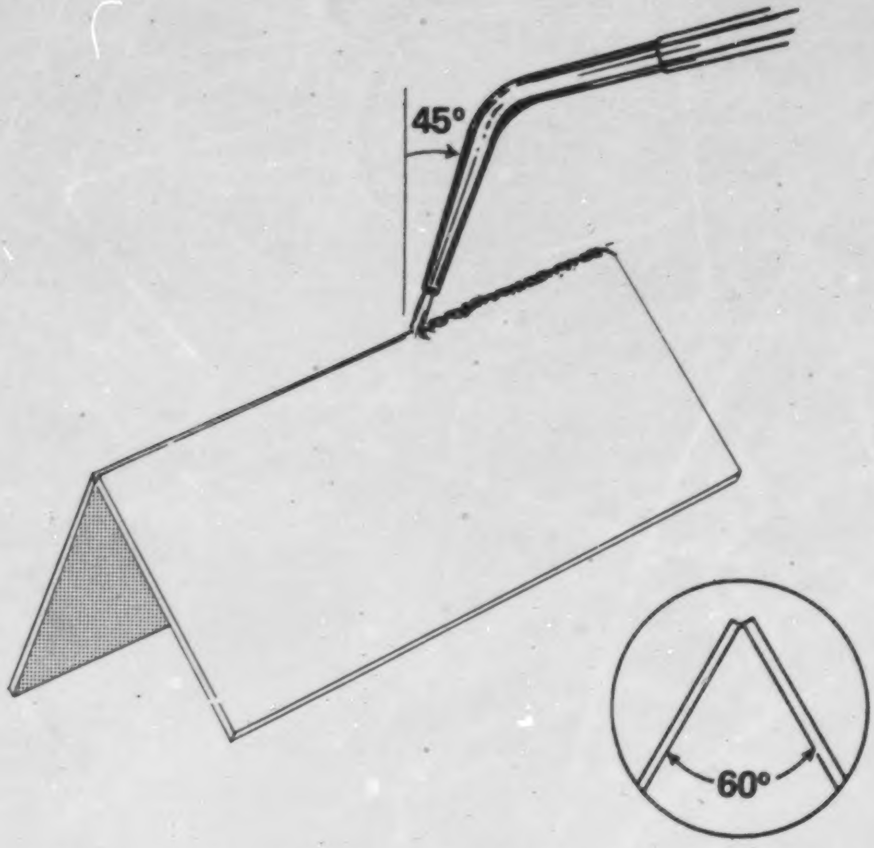
II. Procedure

- A. Prepare metal for welding
- B. Place metal in welding position
- C. Turn on oxyacetylene unit
- D. Set working pressure (according to manufacturer's recommendations)
- E. Light torch and adjust to a neutral flame with very slight feather
- F. Tack weld metal in position
- G. Place inner cone about 1/16" to 1/8" from plate
- H. Do not begin travel until you have established a molten puddle
- I. Begin welding at right end
- J. Hold tip vertically at 45° angle from direction of travel
- K. Slowly move flame down the joint forming puddle as you travel from right to left
- L. Examine welded joint for good bead characteristics and penetration

JOB SHEET #3

M. Repeat process until instructor gives permission to go on to next job

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #4--LAY BEADS ON GAUGE METAL WITHOUT FILLER ROD

I. Tools, materials, and equipment needed

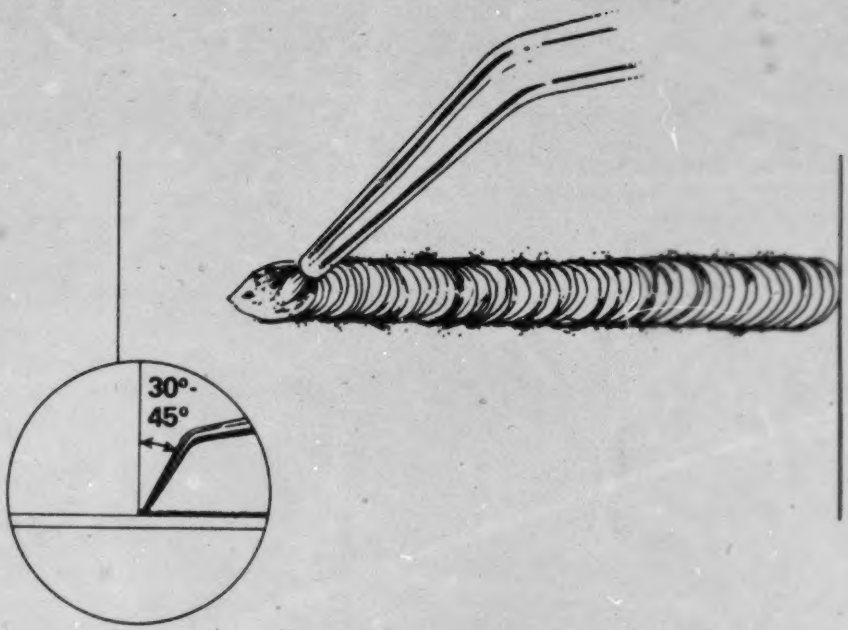
- A. Oxyacetylene welding unit
- B. Welding tip (according to manufacturer's recommendations)
- C. Gloves
- D. Goggles
- E. Pliers
- F. Wire brush
- G. Flint lighter
- H. Fire brick
- I. One piece of 16 gauge mild steel, 1 1/4" x 6"

II. Procedure

- A. Prepare metal for welding
- B. Place metal in welding position
- C. Turn on oxyacetylene unit
- D. Set working pressure (according to manufacturer's recommendations)
- E. Light torch and adjust to a neutral flame
- F. Place inner cone about 1/16" to 1/8" from metal
- G. Do not begin travel until you have established a molten puddle
- H. Hold torch 30° to 45° from center in direction of travel
- I. Slowly move the torch forward allowing the metal to melt
- J. Repeat process until instructor gives permission to go on to next job

JOB SHEET #4

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #5--LAY BEADS ON GAUGE METAL WITH FILLER ROD

I. Tools, materials, and equipment needed

  A. Oxyacetylene welding unit

  B. Welding tip (according to manufacturer's recommendations)

  C. Gloves

  D. Goggles

  E. Pliers

  F. Wire brush

  G. Flint lighter

  H. Fire brick

  I. One piece of mild steel strip, 16 gauge 1 1/4" by 6"

  J. Filler rod mild steel (according to manufacturer's recommendations)

II. Procedure

  A. Prepare metal for welding

  B. Place metal in welding position

  C. Turn on oxyacetylene unit

  D. Set working pressure (according to manufacturer's recommendations)

  E. Light torch and adjust to a neutral flame

  F. Hold torch 30° to 45° from center

  G. Place inner cone about 1/16" to 1/8" from surface of puddle

  H. Do not begin travel until you have established a molten puddle

  I. Add filler rod to front edge of puddle in front of torch

  J. Move puddle forward with torch and allow puddle to form in base metal

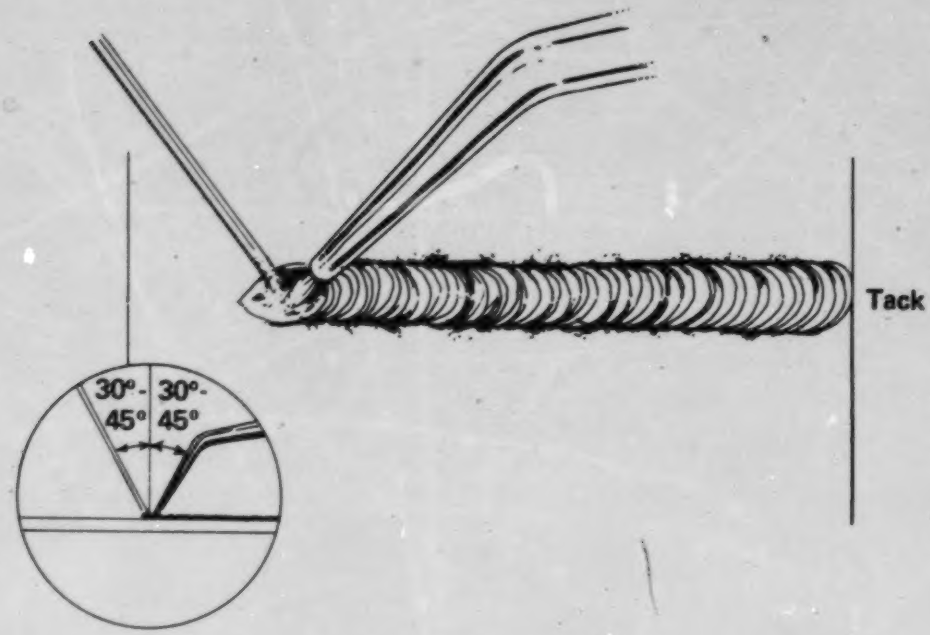
  K. Add rod and withdraw rod to front edge of puddle as you move puddle forward

JOB SHEET #5

L. Keep puddle the same size and shape the entire length of the bead

M. Show bead to instructor when completed

III. Diagram of the procedure



OXYACETYLENE FUSION WELDING
UNIT II

JOB SHEET #6--WELD BUTT JOINTS WITH FILLER ROD

I. Tools, materials, and equipment needed

  A. Oxyacetylene welding unit

  B. Welding tip (according to manufacturer's recommendations)

  C. Gloves

  D. Goggles

  E. Pliers

  F. Wire brush

  G. Flint lighter

  H. Fire brick

  I. Two pieces of mild steel strips, 16 gauge 1 1/4" by 6"

  J. Filler rod mild steel (according to manufacturer's recommendations)

II. Procedure

  A. Prepare metal for welding

  B. Place metal in welding position

  C. Turn on oxyacetylene unit

  D. Set working pressure (according to manufacturer's recommendations)

  E. Light torch and adjust to a neutral flame

  F. Tack weld metal together at both ends of joint

  G. Hold torch 30° to 45° from center

  H. Do not begin travel until you have established a molten puddle

  I. Place inner cone about 1/16" to 1/8" from surface of puddle

  J. Add filler rod to front edge of puddle in front of torch

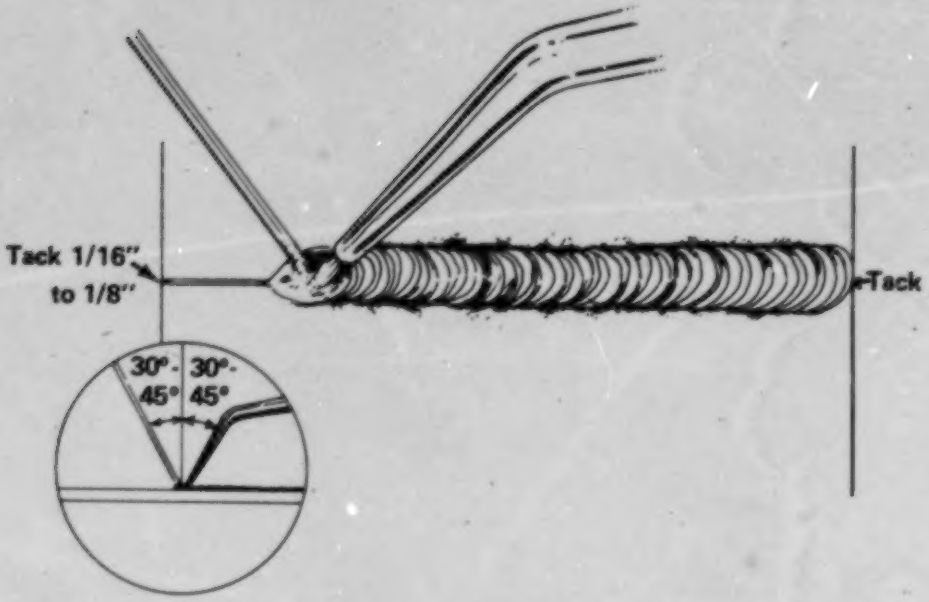
  K. Move puddle forward with torch and allow puddle to form in base metal

JOB SHEET #6

L. Add rod and withdraw rod to front edge of puddle as you move puddle forward

M. Keep puddle the same size and shape the entire length of the bead

III. Diagram of the procedure


Tack 1/16" to 1/8"
Tack
30°-45°
30°-45°

OXYACETYLENE FUSION WELDING
UNIT II

TEST

1. Define the following terms.

   A. Tack weld--

   B. Fusion welding--

   C. Base metal--

   D. Penetration--

   E. Alloy--

   F. Inner cone--

2. List ten safety rules for handling oxygen, acetylene, and oxyacetylene welding equipment.

   a.

   b.

   c.

   d.

   e.

   f.

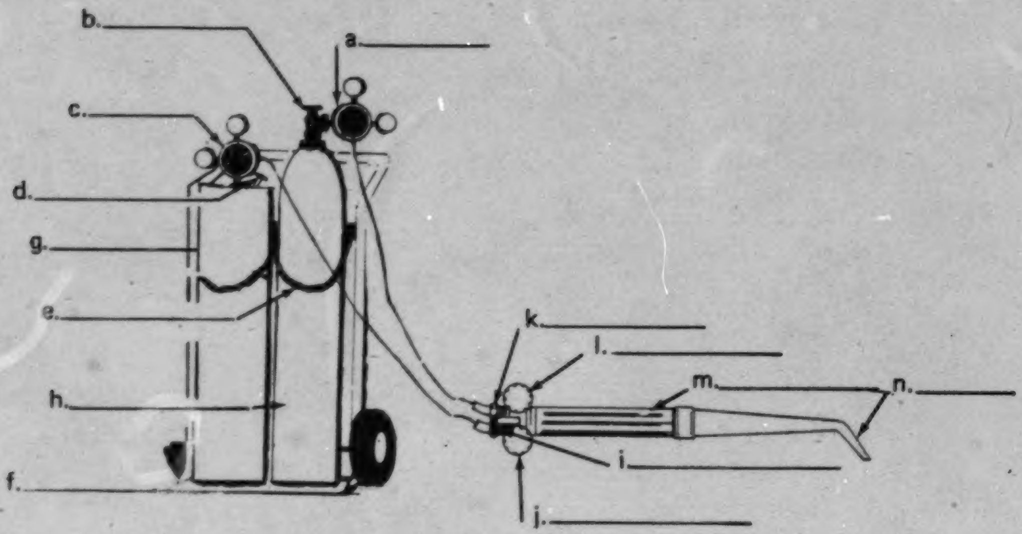
   g.

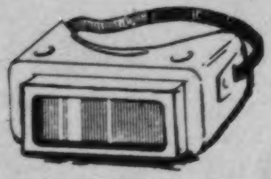
   h.

   i.

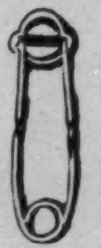
   j.

3. Identify the following oxyacetylene fusion welding equipment.

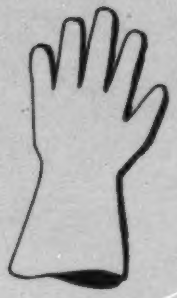

b. ____
a. ____
c. ____
d. ____
g. ____
e. ____
k. ____
l. ____
m. ____
n. ____
h. ____
i. ____
f. ____
j. ____



o. ____



p. ____



q. ____

4. Name five factors that determine fusion weld quality.

   a.

   b.

   c.

   d.

   e.

5. List five properties of a good weld.

   a.

   b.

   c.

   d.

   e.

6. Name two factors that determine tip size in oxyacetylene fusion welding.

   a.

   b.

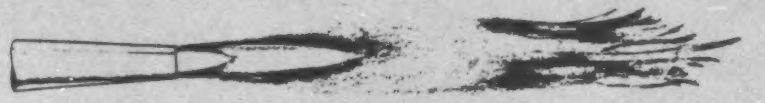
7. List two factors that determine the type of filler rod to use in oxyacetylene fusion welding.

   a.

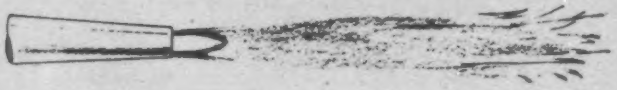
   b.

8. Describe the purpose of the filler rod.

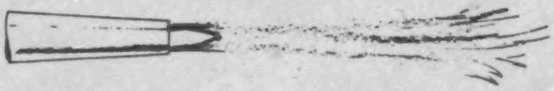
9. Identify the types of oxyacetylene fusion welding flames.



a.______________________________________



b.______________________________________



c.______________________________________

10. Demonstrate the ability to:

a. Set up equipment for oxyacetylene welding.

b. Turn on, light, adjust, and turn off the oxyacetylene welding equipment.

c. Construct a corner weld without filler rod.

d. Lay beads on gauge metal with and without filler rod.

e. Weld butt joints with filler rod.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

OXYACETYLENE FUSION WELDING
UNIT II

ANSWERS TO TEST

1. a. A short weld used for temporarily holding material in place

   b. Joining of pieces of metal by heating the adjoining edges to the fusion or melting point and allowing them to flow or run together and then cool

   c. Metal being welded

   d. Distance from the original surface of the base metal to that point at which fusion ceases

   e. A mixture with metallic properties composed of two or more elements of which one is a metal

   f. The inner white part of the neutral flame

2. Any ten of the following:

   a. Support oxygen and acetylene cylinders in an upright position so they cannot be tipped over

   b. Blow out cylinder valves (crock cylinder valve for a second before attaching regulators) in order to remove dust and dirt that may damage regulator

   c. Release pressure adjusting screw on regulator before opening cylinder valve in order to prevent damage to regulators and possible injury to operator

   d. Stand to the side of regulators keeping the cylinder valve between operator and regulator when opening cylinder valves

   e. Open cylinder valves slowly

   f. Do not use acetylene (in free state) at pressures higher than 15 psi

   g. Purge oxygen and acetylene passages (individually) before lighting torch

   h. Light acetylene before opening oxygen torch valve

   i. Never use oil or grease on regulators, torches, or fittings

   j. Do not use oxygen as a substitute for compressed air

   k. Use safety goggles, gloves, and protective clothing

   l. Have CO_2 or dry powder type fire extinguisher available

m. Test connections for leaks with Ivory soap suds, paint brush, and water

n. Avoid lighting torch or cutting near combustible materials

o. Never open the acetylene cylinder valve more than 1/2-3/4 turns

p. Always operate torch in a well-ventilated area

q. Never cut on containers that have been used for combustible materials

r. Avoid breathing toxic fumes when cutting

s. Place steel caps on all gas cylinders when they are being moved or stored to protect the valves

t. Shut off cylinder valves when not in use for any length of time to reduce the possibility of leakage and strain on the equipment

u. Turn acetylene torch valve off first in order that the flame will go out immediately

v. Keep hands, gloves, and clothing free from oil and grease

w. Never cut or weld too close to concrete

x. Always weld or cut at least five feet from cylinder

y. Always protect hoses from hot metal, rupture, or mechanical damages

z. Always light torch with a friction lighter

aa. Never leave a burning torch unattended

3. a. Oxygen regulator

   b. Oxygen cylinder valve

   c. Acetylene regulator

   d. Acetylene cylinder valve

   e. Safety chain

   f. Cylinder truck

   g. Acetylene cylinder

   h. Oxygen cylinder

   i. Acetylene fitting

   j. Acetylene torch valve

k. Oxygen fitting

l. Oxygen torch valve

m. Welding torch body

n. Welding tip

o. Welding goggles

p. Flint lighter

q. Welding gloves

4. a. Proper flame adjustment

   b. Angle of tip

   c. Distance from work

   d. Speed of travel

   e. Movement of tip

5. a. Consistent width

   b. Straightness

   c. Slightly crowned

   d. Fused into base metal

   e. Clean appearance

6. a. Metal thickness

   b. Size of welding rod

7. a. Rod with similar properties as base metal

   b. Thickness of metal

8. To add strength to weld or joint

9. a. Carburizing

   b. Neutral

   c. Oxidizing

10. Performance skills will be evaluated according to the satisfaction of the instructor.

OXYACETYLENE BRAZE WELDING
UNIT III

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to distinguish between braze and fusion welding and be able to list advantages and disadvantages of brazing. He should be able to demonstrate the procedures for applying flux to a filler rod and construct a butt weld using the brazing process. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Define five terms associated with braze welding.
2. State the differences between brazing and braze welding procedures.
3. List three advantages of braze welding.
4. List three disadvantages of braze welding.
5. List four characteristics of the elements found in the filler rods used in braze welding.
6. State the importance of having a chemically clean metal surface in braze welding.
7. Name the procedures for removing oxides from a clean metal surface.
8. Name five purposes of flux.
9. Name the color of the base metal when the proper temperature is obtained in braze welding.
10. Describe the reaction of the molten bronze when the temperature of the base metal is too hot, too cold, or medium (dull red color).
11. Demonstrate the ability to braze weld a square groove butt joint.

OXYACETYLENE BRAZE WELDING
UNIT III

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Make transparency.

   D. Discuss terminal and specific objectives.

   E. Discuss information sheet.

   F. Demonstrate and discuss procedure outlined in the job sheet.

   G. Give test.

II. Student:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedure outlined in the job sheet.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparency master: TM 1--Braze Welding a Butt Joint

   D. Job Sheet #1--Braze Weld a Square Groove Butt Joint--11GA

   E. Test

   F. Answers to test

II. References:

A. *The Oxyacetylene Handbook: A Manual on Oxyacetylene Welding and Cutting Procedures.* New York: Union Carbide Corporation, Linde Division, 1960.

B. Althouse, Andrew D., Carl H. Turnquist, and William A. Bowditch. *Modern Welding.* Homewood, Illinois: Goodheart-Willcox Company, 1965.

C. Giachino, J. W., William Weeks, and Elmer Brune. *Welding Skills and Practices.* Chicago, Illinois: American Technical Society, 1967.

OXYACETYLENE BRAZE WELDING
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Braze welding--Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted (Transparency 1)

   B. Malleability--A property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

   C. Ductile--A term describing metal which is capable of being drawn or stretched out

   D. Tinning operation--Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

   (NOTE: It is this flow of thin film of bronze which is known as tinning.)

   E. Flux--A chemical used to clean metals and to promote fusion during the welding process

II. Differences between brazing and braze welding procedures

   A. Brazing--A group of welding processes wherein coalescence (the forming together in one mass) is brought about by

      1. Having a joint which requires only a thin film of filler metal

      2. The distribution of filler metal between the closely fitted surfaces of the joint by capillary attraction

      (NOTE: Capillary attraction is the power of a heated surface to draw and spread molten metal.)

   B. Braze welding--Performed in the same manner as fusion welding except that the base metal is not melted

      1. The joint design is the same as used in fusion welding

      2. The welding technique used for braze welding is the same as in fusion welding except that the base metal is raised only to the "tinning" temperature

      (NOTE: The procedures for brazing and braze welding also share common characteristics. The nonferrous filler rod or alloy has a melting point higher than 800° F. but lower than that of the metals or alloys to be joined. Furthermore, although the base metal is never actually melted in braze welding, the bond between the bronze rod and the base metal is such that the results obtained are fully comparable to those obtained through fusion welding.)

INFORMATION SHEET

III. Advantages of braze welding

- A. Less possibility of destroying main characteristics of base metal
  - 1. Base metal does not have to be heated to a molten condition
    - a. This increases the speed of joining metals
    - b. Less gas is consumed for a given job
  - 2. In repairing malleable castings, there is less danger of its losing its ductible properties
- B. The low degree of heat minimizes expansion and contraction forces
- C. Less need for extensive preheating

IV. Disadvantages of braze welding

- A. Not recommended for parts which are to be raised to temperatures higher than the melting point of bronze, either in service or during heat treatment
- B. Bronze will lose its strength at temperatures above 500° F.
- C. It cannot be used on metal where stress is a factor
- D. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

V. Characteristics of the elements found in the filler rods used in braze welding

- A. Consist of copper alloys containing about 60 percent copper and 40 percent zinc which:
  - 1. Produce a high tensile strength
  - 2. Increase ductility
- B. Contain small quantities of tin, iron, manganese, and silicon which help to:
  - 1. Deoxidize the weld metal
  - 2. Decrease the tendency to fume
  - 3. Increase the free-flowing action of the molten metal
  - 4. Increase the hardness of the deposited metal for greater wear resistance

INFORMATION SHEET

VI. Importance of a chemically clean metal surface in bronze welding

A. To guarantee the molten bronze will stick to the base metal

B. To have a stronger bond on base metals

VII. Procedures for removing oxides

A. Mechanical means

1. Wire brush

2. Grinder

B. Chemical--Flux

(NOTE: Both methods should be employed to completely remove the oxides.)

VIII. Purposes of the flux

A. Chemically cleans the base metal

B. Prevents oxidation of the filler metal

C. Floats and removes the oxides already present

D. Increases the flow of the filler metal

E. Increases the ability of the filler metal to adhere to the base metal

F. Brings the filler metal into immediate contact with the metals being joined

G. Permits the filler metal to penetrate the pores of the base metal

IX. Color of base metal when the proper temperature is obtained--A dull red

(NOTE: Base metal will begin to glow.)

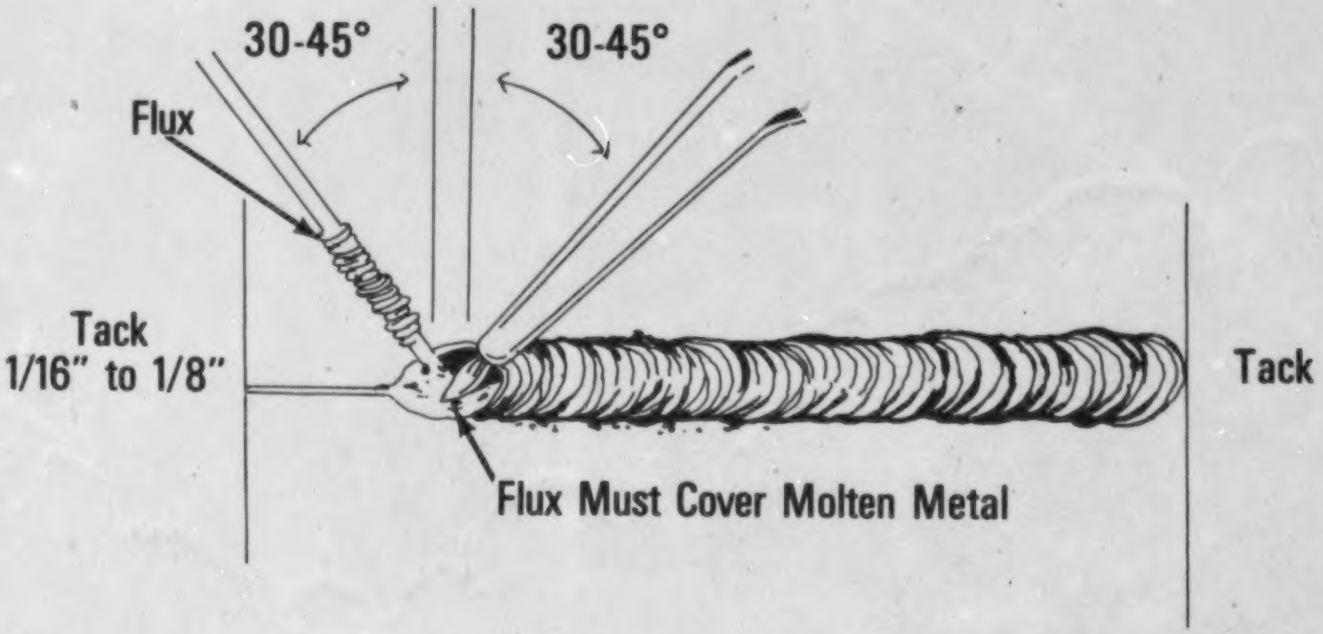
X. Reaction of molten bronze at different temperatures

A. If base metal is not hot enough, the molten bronze, rather than flowing over the surface, will form into drops

B. If the base metal is too hot, the molten bronze tends to boil and to form little balls

C. When the base metal is at the proper temperature, the molten bronze will spread out evenly and flow over a considerable area

Braze Welding A Butt Joint


30-45°
30-45°
Flux
Tack
1/16" to 1/8"
Tack
Flux Must Cover Molten Metal

OXYACETYLENE BRAZE WELDING
UNIT III

JOB SHEET #1--BRAZE WELD A SQUARE GROOVE BUTT JOINT--11GA

I. Tools and materials needed

   A. Oxyacetylene welding unit

   B. Gloves

   C. Safety glasses

   D. Goggles

   E. Welding tip (According to manufacturer's recommendations)

   F. Wire brush

   G. Flint lighter

   H. Fire brick

   I. Two pieces of clean mild steel strips, 1/8" thick, 1 1/4" by 6"

   J. Bronze filler rod (Use according to manufacturer's recommendations)

   K. Welding flux

II. Procedure

   A. Prepare metal for brazing--clean

   B. Place metal in brazing position--1/16" to 1/8" apart

   C. Turn on oxyacetylene unit

   D. Adjust proper working pressure of oxygen and acetylene (Use manufacturer's recommendations)

   E. Place metal on fire brick

   (NOTE: Do not lay metal flat on brick. Arrange metal so a small space will be between the base metal and the fire brick.)

   F. Light and adjust torch to a neutral or slightly oxidized flame

   G. Preheat the end of the brazing rod and dip in the flux or use fluxed rod

JOB SHEET #1

H. Tack metal in place using braze filler metal

I. Heat the surface of the weld area slightly

J. Hold torch 30° to 45° from vertical; hold filler rod at the same angle in opposite direction

K. Melt a small amount of bronze rod onto the surface and allow it to spread along the entire seam when a dull cherry-red color occurs

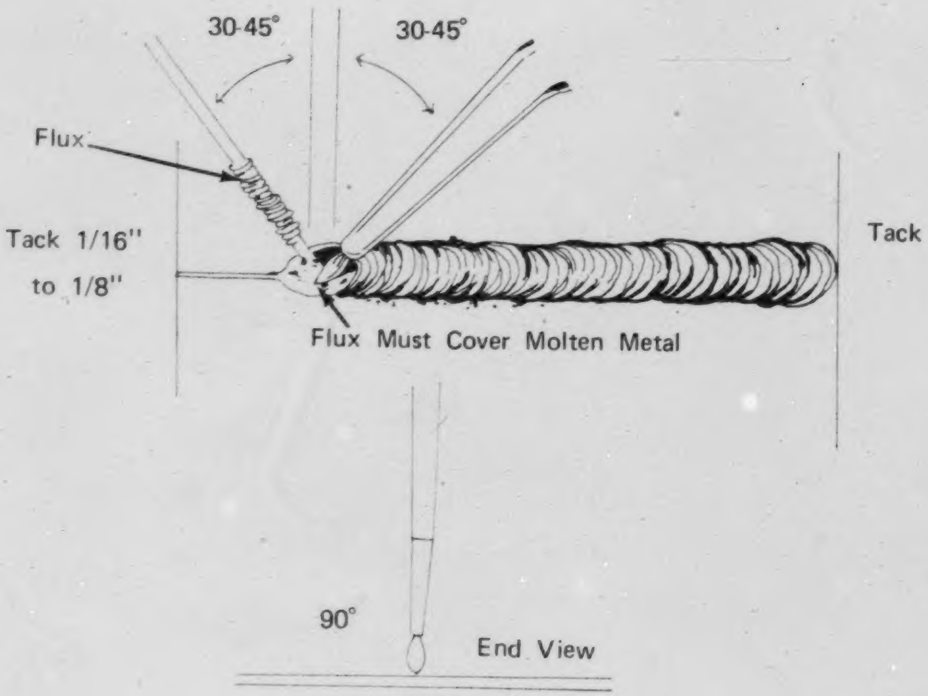
L. When the base metal is tinned sufficiently, start depositing the proper size bead

M. Watch for base metal color

(NOTE: When metal is not hot enough, the bronze will form into drops; when metal is too hot, bronze tends to boil. This is indicated by excessive white smoke.)

N. Inspect weld then check with instructor

III. Diagram of the procedure



OXYACETYLENE BRAZE WELDING
UNIT III

TEST

1. Define the following terms.
   a. Flux–
   b. Ductile--
   c. Malleability–
   d. Braze welding–
   e. Tinning operation--
2. State the differences between brazing and braze welding procedures.
3. List three advantages of braze welding.
   a.
   b.
   c.
4. List three disadvantages of braze welding.
   a.
   b.
   c.

5. List four characteristics of the elements found in the filler rods used in braze welding.

   a.

   b.

   c.

   d.

6. State the importance of having a clean metal surface in braze welding.

7. Name the procedures for removing oxides from a clean metal surface.

   a.

   b.

8. Name five purposes of flux.

   a.

   b.

   c.

   d.

   e.

9. Name the color of the base metal when the proper temperature is obtained in braze welding.

10. Describe the reaction of the molten bronze when the temperature of the base metal is:

    a. Medium (dull red color)

    b. Too hot

    c. Not hot enough

11. Demonstrate the ability to braze weld a square groove butt joint--11ga.

OXYACETYLENE BRAZE WELDING
UNIT III

ANSWERS TO TEST

1. a. Flux–A chemical used to clean metals and to promote fusion during the welding process

   b. Ductile--A term describing metal which is capable of being drawn or stretched out

   c. Malleability--A property of metals which allows them to be bent or permanently distorted without rupture; opposite of brittleness

   d. Braze welding--Heating the base metal to a dull red color and depositing a bead over the seam (joint) with a bronze filler rod; the base metal is not melted

   e. Tinning operation--Melting a small amount of bronze rod onto the surface and allowing it to spread along the entire seam (joint)

2. a. Brazing--A group of welding processes wherein coalescence (the forming together in one mass) is brought about by

      1. Having a joint which requires only a thin film of filler metal

      2. The distribution of filler metal between the closely fitted surfaces of the joint by capillary attraction

   b. Braze welding--Performed in the same manner as fusion welding except that the base metal is not melted

      1. The joint design is the same as used in fusion welding

      2. The welding technique used for braze welding is the same as in fusion welding except that the base metal is raised only to the "tinning" temperature

3. a. Less need for extensive preheating

   b. The low degree of heat minimizes expansion and contraction forces

   c. Less possibility of destroying the main characteristics of the base metal

4. Any three of the following

   a. Not recommended for parts which are to be raised to temperatures higher than the melting point of bronze, either in service or during heat treatment

   b. It cannot be used on metal where stress is a factor

   c. Bronze may have corrosion-resistant properties which differ from those of the base metal being used

   d. Bronze will lose its strength at temperatures above 500° F.

5. Any four of the following

   a. Deoxidize the weld metal

   b. Decrease the tendency to fume

   c. Increase the free-flowing action of the molten metal

   d. Increase the hardness of the deposited metal for greater wear resistance

   e. Produce a high tensile strength

   f. Increase ductility

6. a. To guarantee the molten bronze will stick to the base metal

   b. To have a stronger bond on base metal

7. a. Mechanical--Wire brush or grinder

   b. Chemical--Flux

8. Any five of the following

   a. Chemically cleans the base metal

   b. Prevents oxidation of the filler metal

   c. Floats and removes the oxides already present

   d. Increases the flow of the filler metal

   e. Increases the ability of the filler metal to adhere to the base metal

   f. Brings the filler metal into immediate contact with the metals being joined

   g. Permits the filler metal to penetrate the pores of the base metal

9. Dull red

10. a. The molten bronze will spread out evenly and flow over a considerable area

    b. The molten bronze will tend to boil and to form little balls

    c. The molten bronze will not flow over the surface but will form into drops

11. Performance skills will be evaluated to the satisfaction of the instructor.

SHIELDED METAL ARC WELDING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to name three kinds of arc welders, distinguish between straight and reverse polarity, and select the correct electrode for the job. He should be able to demonstrate the ability to start, stop, and restart a bead, construct a pad in a flat position, and construct a square groove butt weld. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with shielded metal arc welding with the correct definition.
2. Name four types of arc welding machines.
3. Name the common equipment needed in shielded metal arc welding.
4. Distinguish between straight and reverse polarity.
5. Select from a list alternatives that determine the polarity to use in shielded metal arc welding.
6. Name the two types of operating adjustments found on arc welding machines.
7. Discuss in a short paragraph how to test for polarity.
8. Name four common types of electrodes.
9. Name four common sizes of electrodes.
10. Select from a list alternatives illustrating how electrode size is determined.
11. Select the purposes of flux coating on electrodes.
12. Identify the meaning of the numbers in the AWS electrode code classification.
13. Name five factors to be considered when selecting an electrode for a specific job application.
14. Name four types of welds.

15. Identify the parts of groove and fillet welds.
16. Identify five types of weld joints.
17. Select reasons for poor welds when given a list of alternatives.
18. Identify the parts of the welding process when presented a drawing of the process.
19. Name the two methods of striking an arc.
20. Name five safety precautions to follow in shielded metal arc welding.
21. Select the correct lens to use when given the welding operation.
22. Demonstrate the ability to perform the following tasks:
    a. Start, stop, and restart a bead.
    b. Strike an arc and construct a pad in flat position, using E-6010 rod, by running uniform beads on mild steel plate which is one-fourth inch to three-eighths inch thick.
    c. Construct a square groove butt weld on three-sixteenths inch or one-fourth inch steel plate with one-hundred percent penetration, using a single pass with E-6010 rod.

SHIELDED METAL ARC WELDING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information and job sheets.

  C. Make transparencies.

  D. Discuss terminal and specific objectives with students.

  E. Discuss information sheet.

  F. Demonstrate and discuss the procedures outlined in the job sheets.

  G. Give test.

II. Student:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objective sheet

  B. Information sheet

  C. Transparency masters

    1. TM 1--Welding Circuit

    2. TM 2--Standardized AWS Classification

    3. TM 3--Types of Welds

    4. TM 4--Parts of a Weld

    5. TM 5--Types of Joints

    6. TM 6--Direction of Travel

D. Job sheets

   1. Job Sheet #1--Start, Stop, and Restart the Arc

   2. Job Sheet #2--Make a Pad in the Flat Position

   3. Job Sheet #3--Make a Square Groove Butt Weld

E. Test

F. Answers to test

II. References:

A. Jones, M. M. *Shopwork on the Farm.* New York: McGraw-Hill Book Company, Inc.,

B. Phipps, Lloyd, J., H. F. McColly, L. L. Scranton, and G. C. Cook. *Farm Mechanics Text and Handbook.* Danville, Illinois: The Interstate Printers and Publishers, Inc.

C. Kugler, Harold L. *Arc Welding Lessons for School and Farm Shop.* James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

D. Hollenberg, A. H. *How to Teach Arc Welding in Farm Mechanics.* James F. Lincoln Arc Welding Foundation, Cleveland, Ohio.

E. *Hobart Welding School Workbook.* Troy, Ohio: Hobart Brother's Technical Center.

F. *New Lessons in Arc Welding.* Cleveland, Ohio: The Lincoln Electric Company, James F. Lincoln Arc Welding Foundation.

G. *Welding Processes and Power Sources Study Guide and Workbook.* E. R. Pierre, Power Publications Company, P.O. Box 96, Appleton, Wisconsin 54911.

SHIELDED METAL ARC WELDING
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Shielded metal arc welding--An arc welding process wherein metals are united by heating with an electric arc between a coated metal electrode and the metal

   B. Arc--The flow of electric current from the tip of the electrode to the base of the metal being welded

   C. Electrodes--Metal rods which conduct a current from the electrode holder to the base metal

   D. Base metal--The metal to be welded or cut

   E. Arc length--The distance from the end of the electrode to the point where the arc makes contact with work surface

   F. Crater--A depression at the termination of a weld

   G. Face of weld--The exposed surface of a weld, made by an arc or gas welding process, on the side from which welding was done

   H. Flux--A fusible material or gas used to dissolve and/or prevent the formation of oxides, nitrides, or other undesirable inclusions formed in welding

   I. Low carbon steel--Steel containing .20% or less carbon

   J. Pass--A single longitudinal progression of a welding operation along a joint or weld deposit

   K. Porosity--Gas pockets or voids in metal

   L. Spatter--The metal particles given off during welding which do not form a part of the weld

   M. Tack weld--A weld made to hold parts in proper alignment until the final welds are made

      (NOTE: This type of welding is for assembly purposes only.)

   N. Puddle--That portion of a weld that is molten at the place the heat is supplied

   O. Undercut--A groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal

   P. Weaving--A technique of depositing weld metal in which the electrode is oscillated

INFORMATION SHEET

- Q. Weld metal--That portion of a weld which has been melted during welding
- R. Whipping--A term applied to an inward and upward movement of the electrode which is employed in vertical welding to avoid undercut
- S. AWS--American Welding Society
- T. Disposition rate--The amount of filler metal deposited in any welding process; rated in pounds per hour

II. Types of arc welding machines

- A. AC (Alternating current) transformer welder--Current alternating direction 120 times per second
- B. AC-DC--Transformer rectifier--Provides either alternating current or direct current
- C. Motor generator--Produces DC current
- D. Engine generator--Produces DC current

III. Common equipment

- A. Welding machine
- B. Electrode holder with lead
- C. Ground clamp with lead
- D. Shield or helmet
- E. Gloves
- F. Chipping hammer
- G. Safety goggles
- H. Wire brush
- I. Electrodes
- J. Pliers
- K. Protective clothing

INFORMATION SHEET

IV. Polarity (Transparency 1)

   A. Reverse--Current flows from base metal to electrode

   B. Straight--Current flows from electrode to base metal

   (NOTE: Welding leads must connect to correct terminals if machine has a polarity switch. Otherwise a change in polarity is made by reversing leads on the terminals.)

V. Factors that determine polarity--Electrode and type of flux on electrode

   A. E-6010 DC (+) reverse polarity

   B. E-6012 AC-DC (-) straight polarity

   C. E-7018 AC-DC (+) reverse polarity

   D. E-7024 AC-DC (±) Reverse or straight polarity

VI. Operating machine adjustments

   A. Current (amperage) settings

      1. Increasing amps--Produces more heat

      2. Decreasing amps--Produces less heat

   B. Polarity

VII. Testing for polarity

   A. Weld a bead using E-6010 reverse polarity electrode

   (NOTE: If there is excessive amount of weld spatter and arc is very erratic, machine is set on straight polarity (electrode lead negative, work lead (ground) positive. Reverse polarity should have electrode positive, work lead (ground) negative. The same practice would apply if machine is set on A.C.)

   B. Strike arc with carbon electrode

   (NOTE: If arc is smooth and quite, it is set on straight polarity. If carbon becomes extremely hot and pieces break off and black smudges appear on work piece, it is set on reverse polarity.)

INFORMATION SHEET

VIII. Types of electrodes

- A. Mild steel
- B. Low hydrogen-low alloy
- C. Non-ferrous
- D. Hard surfacing
- E. Cast iron
- F. Stainless steel

Example:

WELDING CHARACTERISTICS AND OPERATING DATA OF MILD STEEL ELECTRODES

	Coating Color	Position of Welding	Type of Current* Used	Penetration	Rate of Deposition	Appearance of Bead	Minimum Tensile Strength	3/32" Size	1/8" Size	5/32" Size	3/16" Size
E6010	White	All Positions	DC, Reverse (+)	Deep	Av. Rate	Rippled and Flat	62,000psi		75-130	90-175	140-225
E6011	White	All Positions	AC DC, Reverse (+)	Deep	Av. Rate	Rippled and Flat	62,000psi		75-120 70-110	90-160 80-145	120-200 110-180
E6012	Tan	All Positions	DC, Str. AC (-)	Medium	Good Rate	Smooth and Convex	67,000psi	55-80 60-90	80-135 90-150	110-180 120-200	155-250 170-275
E6013	Dark Tan	All Positions	AC DC, Str. (-) or Reverse	Mild	Good Rate	Smooth, Flat and Convex	67,000psi	65-100 60-90	90-140 80-125	140-200 125-180	200-260 180-235
E7014	Gray-Br.	All Positions	AC DC, Str. (-) or Reverse	Medium	High Rate	Smooth, Flat and Convex	70,000		110-160 100-145	150-225 1350200	200-280 180-250
E7016		All Positions	AC DC, Reverse (+)	Mild to Medium	Good Rate	Smooth and Convex	70,000	70-100	80-130	120-170	170-250
E7024	Dark Gray	Flat Hor. Fillets	AC, DC Straight or Reverse	Mild	Very High Rate	Smooth and Slightly Cvx	72,000	65-120 60-110	115-175 100-160	180-240 160-215	240-300 220-280
E6027	Red Brown	Flat Hor. Fillets	Flat-DC,AC Hor. Fillet DC Str. AC	Medium	Very High Rate	Flat to Concave	62,000psi			190-240 175-215	250-300 230-270
E7018	Gray	All Positions	AC DC, Reverse (+)	Mild	High Rate	Smooth, Flat to Convex	72,000	70-100 80-120	90-150 110-170	120-190 135-225	170-280 200-300
E7028	Gray-Br.	Flat Hor. Fillets	AC DC, Reverse (+)	Mild	Very High Rate	Smooth and Slightly Cvx	72,000			180-270 170-240	240-330 210-300

*DC Reverse means DC, reverse polarity (electrode positive).
DC Straight means DC, straight polarity (electrode negative).

INFORMATION SHEET

IX. Common electrode sizes

   A. Range in size from 1/16" to 5/16"

   B. Common sizes 3/32", 1/8", 5/32", 3/16", 7/32", 1/4", 5/16"

X. Determining electrode size--Determined by diameter of bare end of electrode

XI. Purposes of flux coating

   A. Stabilizes arc

   B. Shields molten puddle from air

   C. Floats impurities out of puddle

   D. Forms slag and slows cooling

   E. Provides deoxidizers and scavengers to prevent porosity of weld zone

   F. Provides alloying elements for higher strength welds

   G. Provides iron powder to increase the disposition rate

XII. A.W.S. electrode classification (Transparency 2)

   A. E--Stands for electrode

   B. First two digits--Indicate tensile strength deposited in a thousand pounds per square inch

   C. Third number--Indicates welding position

      1. All positions

      2. Flat and horizontal

   D. Fourth digits--Represents special characteristics and usability of the rod

      1. Current

      2. Penetration

      3. Type of flux coating

XIII. Factors for selecting electrodes

   A. Base metal strength properties

   B. Base metal composition

   C. Welding position

INFORMATION SHEET

D. Welding current

E. Joint design and fit-up

F. Thickness and shape of base metal

G. Service conditions and/or specification

H. Production efficiency and job conditions

XIV. Types of welds (Transparency 3)

A. Bead

B. Fillet

C. Groove

D. Plug

XV. Parts of groove and fillet welds (Transparency 4)

A. Groove weld

1. Face
2. Root
3. Root face
4. Root opening
5. Groove face
6. Groove angle
7. Bevel angle
8. Throat

B. Fillet weld

1. Toe
2. Face
3. Throat
4. Leg
5. Root

INFORMATION SHEET

XVI. Types of weld joints (Transparency 5)

  A. Butt
  B. Corner
  C. Tee
  D. Lap
  E. Edge

XVII. Reasons for poor welds

  A. Improper machine adjustment
  B. Improper electrode and size
  C. Improper movement of electrode
  D. Improper angle of electrode
  E. Improper base metal preparation
  F. Improper arc length

XVIII. Parts of welding process (Transparency 6)

  A. Slag
  B. Weld
  C. Electrode
  D. Wire core
  E. Coating
  F. Arc
  G. Crater
  H. Penetration
  I. Base metal
  J. Heat lines
  K. Gaseous shield
  L. 10° - 15°

INFORMATION SHEET

XIX. Methods of striking arc

- A. Tapping
- B. Scratching

XX. Safety precautions

- A. Keep equipment in good, clean, dry condition
- B. Make sure all electrical connections are tight, clean, and dry
- C. Use correct size welding cable--Do not overload
- D. Be sure cables, holder, and connections are properly insulated
- E. Cut off power to welder before cleaning machine or making internal adjustments
- F. Never change polarity or current settings while machine is under load
- G. Observe normal operating care for electrical hazards
- H. Keep work area neat, clean, and dry
- I. Remove flammable materials from welding area or shield them
- J. Do not weld near volatile, flammable liquids or gases
- K. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion
- L. Dispose of hot electrode stubs in a metal container
- M. Never strike an arc on a compressed gas cylinder
- N. Protect your eyes from rays of the arc; wear a headshield with the proper filter plates when welding or cutting
- O. Wear protective chipping goggles when chipping off weld slag

  (NOTE: Chip away from your face.)
- P. Wear leather gloves and protective clothing such as an apron, sleeves, etc. to shield against the arc rays and sparks; button up shirt collar
- Q. Use a non-reflecting welding curtain to protect others in the area from the arc rays

INFORMATION SHEET

R. Be sure work area has adequate ventilation-plenty of fresh air; special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium

S. Do not pick up hot metal

T. Always open main switch or disconnect plug when checking over a welder

U. Do not leave electrode holder on welding table or in contact with grounded metal surface

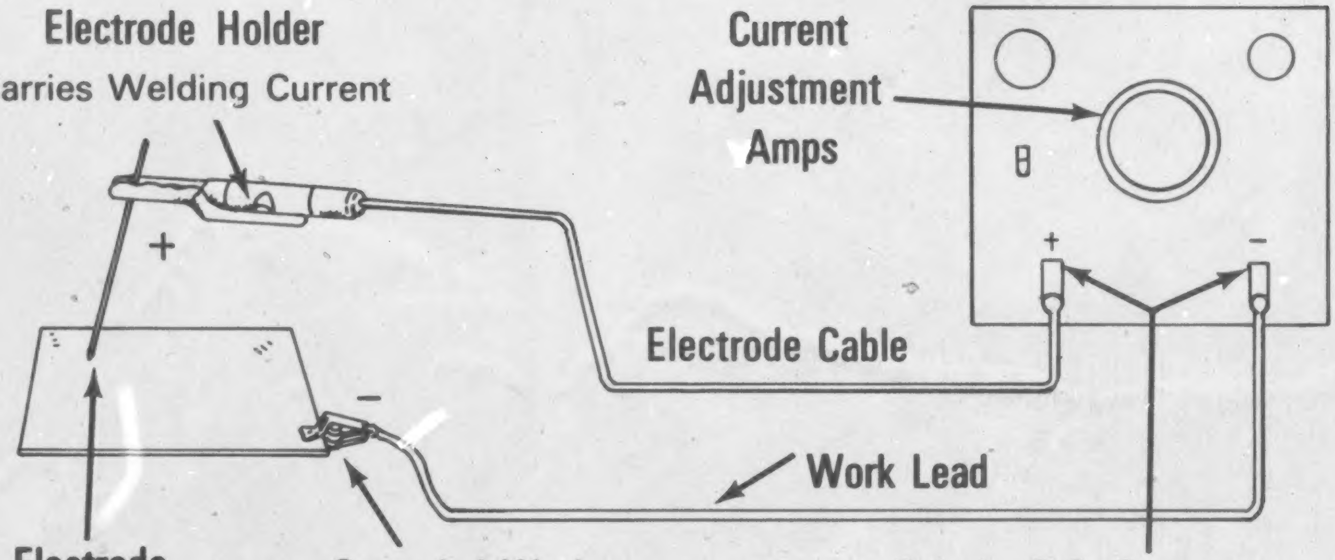
V. Keep tools and metal in their proper locations

XXI. Safety lens

LENS SHADE SELECTOR

Type of operation	Shade number
Soldering	2
Torch brazing	3 or 4
Oxygen cutting	
0 - 1 inch	3 or 4
1 - 6 inches	3 or 5
6 inches and over	5 or 6
Gas welding	
0 - 1/8 inch	4 or 5
1/8 to 1/2 inch	5 or 6
1/2 inch and over	6 or 8
Shielded metal arc welding	
1/16, 3/32, 1/8, 5/32 inch electrodes	9 - 14
Gas Metal Arc Welding	
Gas tungsten arc welding	9 - 14
Nonferrous, gas metal arc welding	
1/16, 3/32, 1/8, 5/32 inch electrode	
Gas tungsten arc welding (ferrous),	9 - 14
gas metal arc welding (ferrous)	
1/16, 3/32, 1/8, 5/32 inch electrodes	

Welding Circuit



Welding Machine

Current
Adjustment
Amps

Electrode Holder

Carries Welding Current

Electrode Cable

Work Lead

Electrode

Diameters:
1/16 - 5/16 x 14'
Most Common
Length

Grounded Work

Completes
Welding Circuit

Polarity-D.C. Current

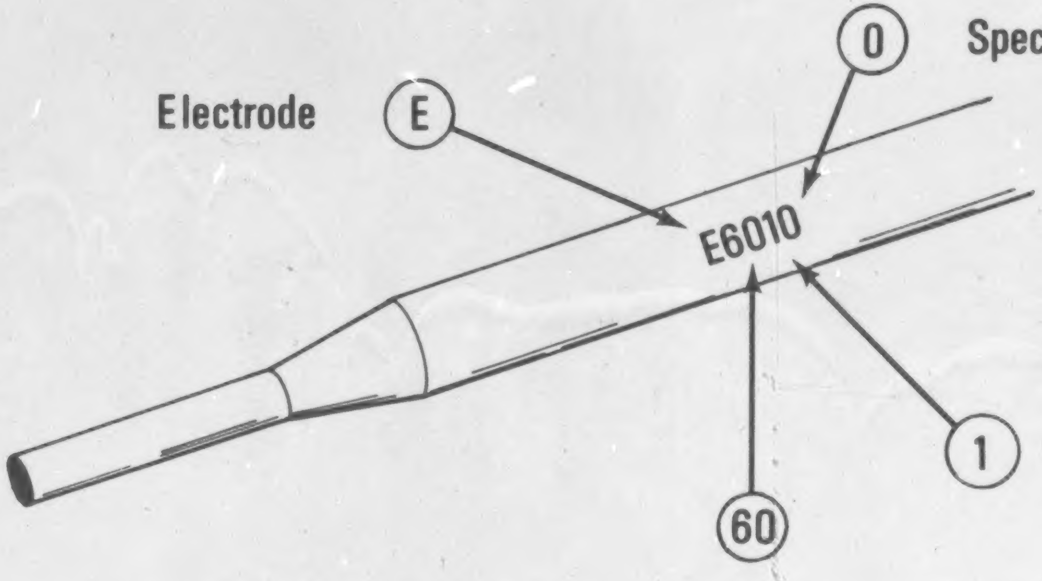
Reverse:

1. Electrode (+)
2. Current flows from work to electrode
3. 2/3 heat at (+) electrode
   1/3 heat at (-) work

Straight:

1. Electrode (-)
2. Current flows from electrode to work
3. 2/3 heat at (-) work
   1/3 heat at (+) electrode

Standardized AWS Classification



Electrode

Special Characteristics

current
penetration
type of flux
coating

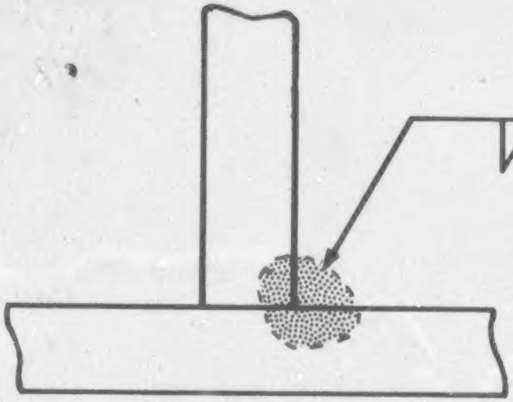
Welding Positions

1. all positions
2. flat and horizontal

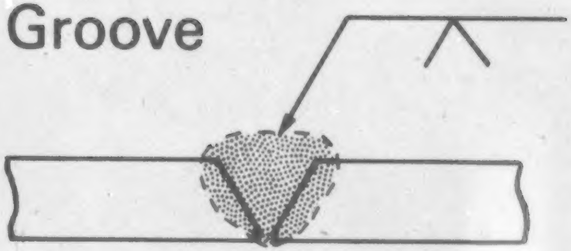
Tensile Strength 1,000 Lbs. Per Sq. Inch

E6010 Mild Steel Electrode

Types of Welds

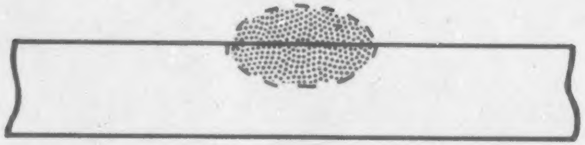


Fillet

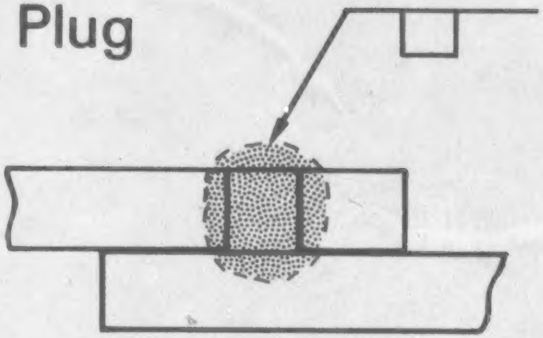


Groove

END VIEW

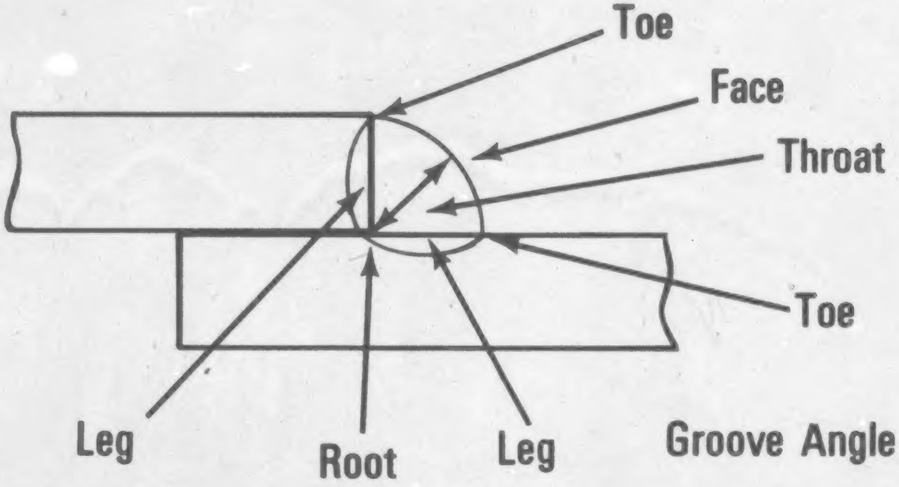


Bead

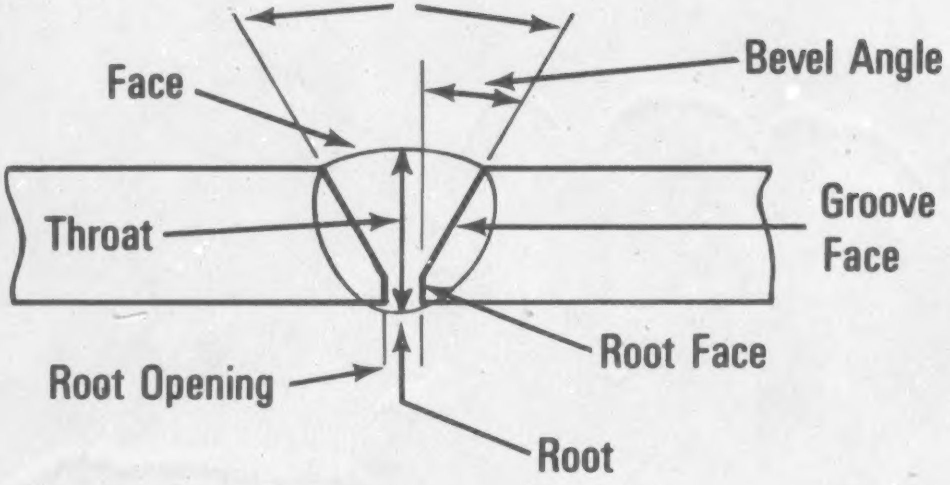


Plug

Parts of a Weld


Toe
Face
Throat
Toe
Leg
Root
Leg

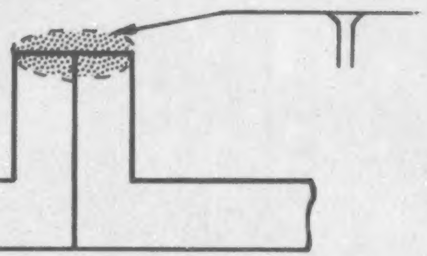
FILLET WELD


Groove Angle
Bevel Angle
Face
Throat
Groove Face
Root Face
Root Opening
Root

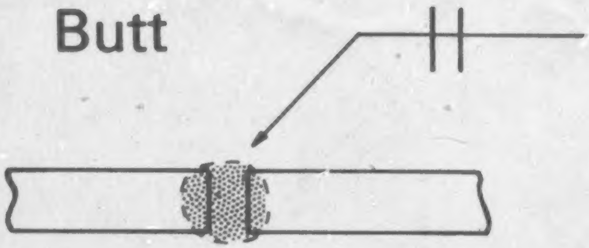
GROOVE WELD

Types of Joints

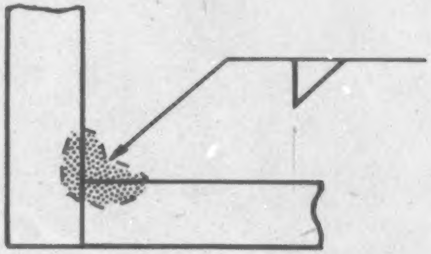
Edge



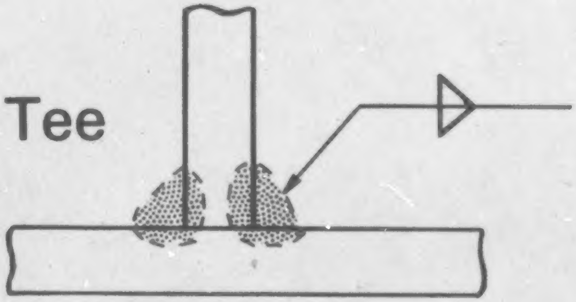
Butt



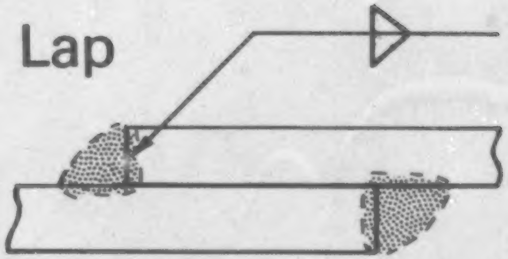
Corner



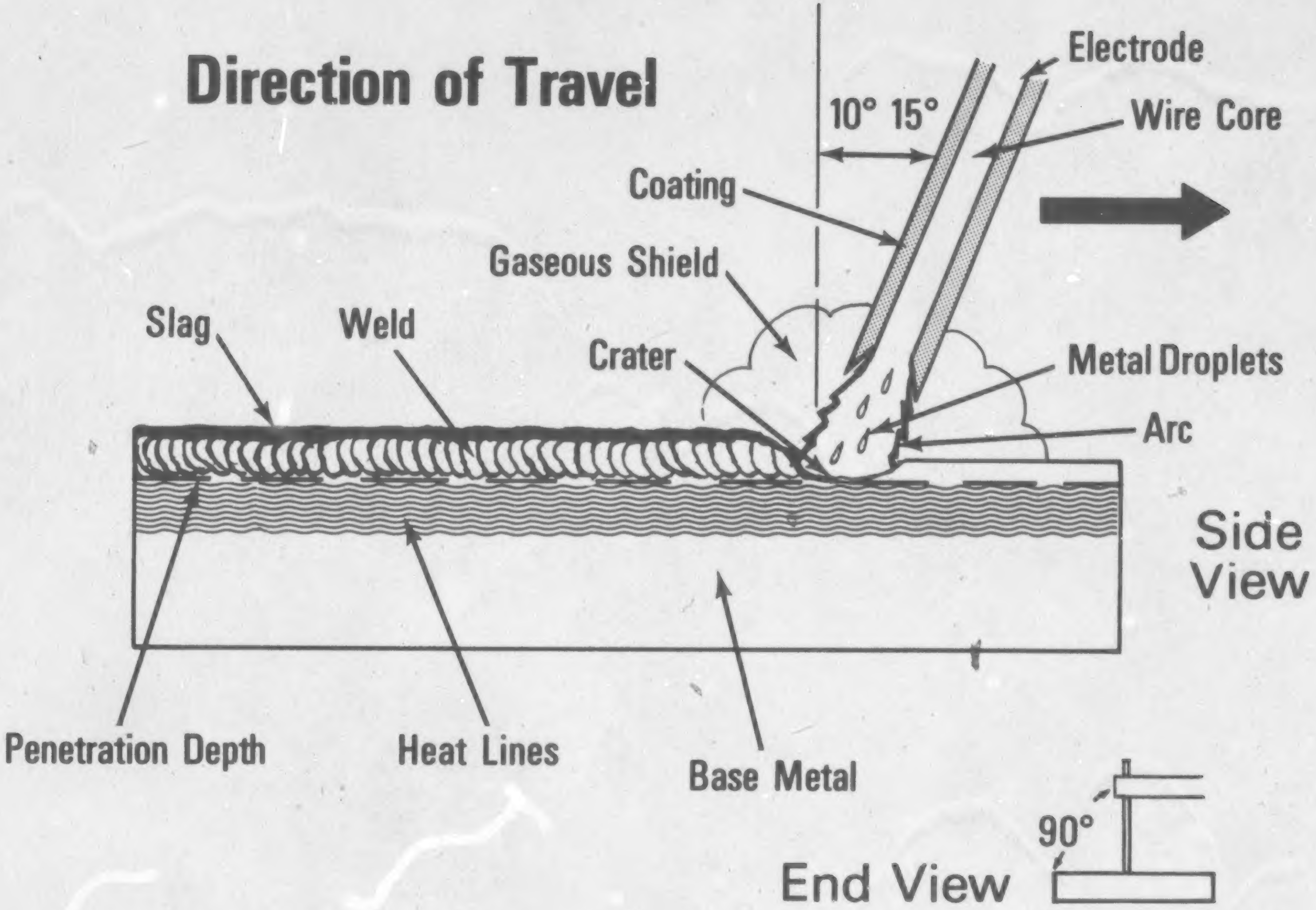
Tee



Lap



Direction of Travel


10° 15°
Electrode
Wire Core
Coating
Gaseous Shield
Slag
Weld
Crater
Metal Droplets
Arc
Side View
Penetration Depth
Heat Lines
Base Metal
90°
End View

SHIELDED METAL ARC WELDING
UNIT I

JOB SHEET #1--START, STOP, AND RESTART THE ARC

I. Equipment and materials

   A. Metal--1/4" to 3/8", 4" x 4"

   B. Welding machine and accessories

   C. Welding helmet

   D. Protective clothing

   E. E-6010 electrode--1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   F. Current DCRP (+) at the electrode

   G. Chipping hammer

   H. Wire brush

II. Procedures

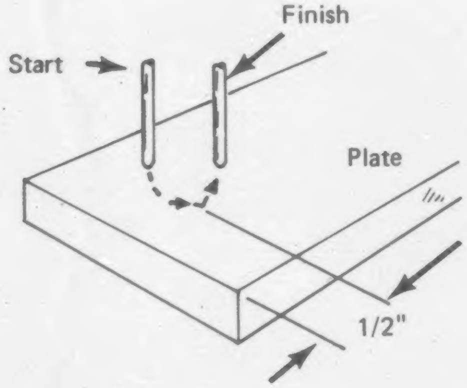
   A. Starting a bead

      1. Adjust machine to desired welding current

         (NOTE: This desired current will depend on type and size of electrode, and thickness of metal. Refer to Chart #1.)

      2. Hold electrode perpendicular to work where weld is to start (Figure 1)

FIGURE 1



JOB SHEET #1

3. Slant electrode 10° to 15° in direction of travel

4. Lower electrode and tap or scratch lightly on edge of plate

   (NOTE: This procedure is necessary for establishing an arc.)

5. Momentarily raise electrode upon establishment of arc

   (NOTE: This preheats the edge of metal and prevents a cold start.)

6. Lower electrode to correct arc length

7. Rotate electrode

   (NOTE: To build up desired height of bead and to obtain desired width of bead. When desired crater develops, move out slowly using normal manipulation.)

B. Stopping bead

1. Return electrode to 90° or perpendicular to work

2. Reverse electrode and hold until crater fills

   (NOTE: This causes crater build up, removes impurities from weld, and prevents crater from cracking.)

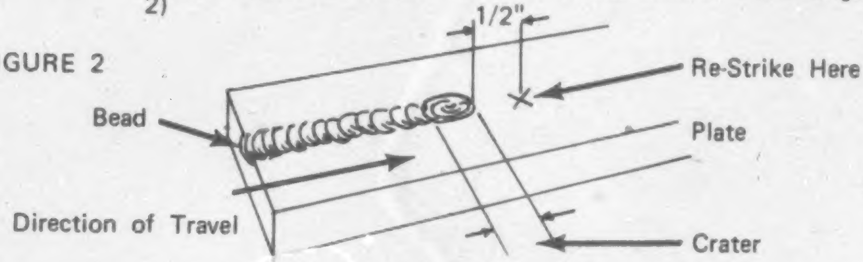
3. Raise electrode quickly when desired width and height of bead is formed

C. Restarting a bead

1. Start arc about 1/2" to 3/4" in front of crater

2. With a long arc, move electrode back to within 1/16" of the crater crown, fill to bead size then resume normal travel (Figure 2)

FIGURE 2



3. Fuse new crater into last ripple of crater

4. Maintain correct width of bead while completing weld

   (NOTE: Arc length is correct when it makes a "frying" noise. The force of the arc determines penetration and bead appearance.)

SHIELDED METAL ARC WELDING
UNIT I

JOB SHEET #2--MAKE A PAD IN THE FLAT POSITION

I. Equipment and materials

  A. Mild steel metal 3/8" thick, 6" by 6"

  B. Welding machine and accessories

  C. Welding helmet

  D. Protective clothing

  E. E-6010 electrodes--1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  F. Current DCRP (+) at the electrode

  G. Chipping hammer

  H. Wire brush

  I. Pliers or vise grips

II. Procedures

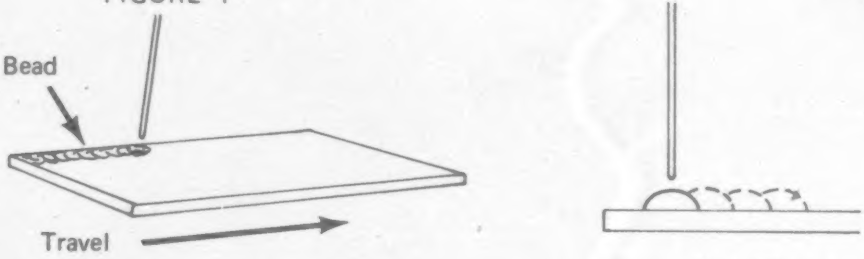
  A. Set welding machine

  B. Prepare and place metal in flat position

  (NOTE: Remove all dirt, grease, and mill scale from surfaces of metal.)

  C. Run a straight bead near edge of plate (Figure 1)

FIGURE 1



End View

(NOTE: For the first bead, the electrode should be held almost vertical. NO side angle.)

(CAUTION: Avoid burning off edge of plate.)

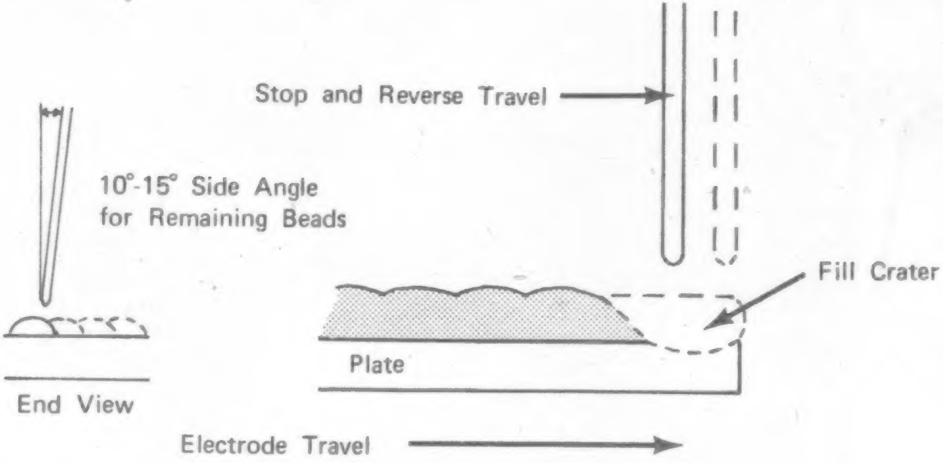
JOB SHEET #2

D. After laying first bead, chip and brush it clean and check surface

(NOTE: The surface appearance should be smooth and even. Check for pinholes, crater holes, slag holes, or indications of improper starts and stops. Also, checking the bead will identify if current needs to be changed.)

E. Reverse travel and run additional beads, remember to overlap at least the first one-third of the previous bead (Figure 2)

FIGURE 2


Stop and Reverse Travel
10°-15° Side Angle for Remaining Beads
Fill Crater
Plate
End View
Electrode Travel

(NOTE: The electrode should be held at 10° to 15° to the side for this bead and all other beads.)

F. Clean each pass thoroughly before overlapping with another

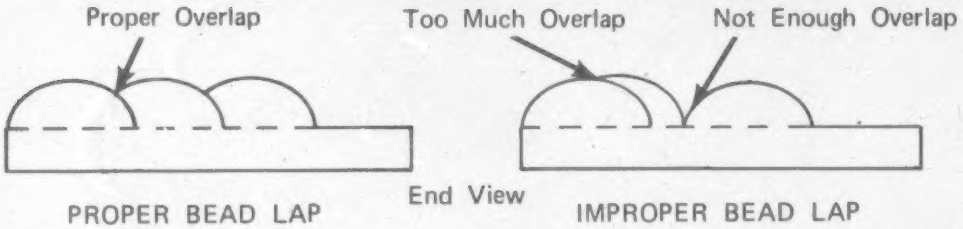
(NOTE: This will insure a sound deposit with proper penetration and no slag holes.)

JOB SHEET #2

G. Fuse each pass with base metal as well as with the preceding pass (Figure 3)

(NOTE: Alternate travel direction for each pass

FIGURE 3



PROPER BEAD LAP

Beads should not over or underlap each other. Note approximate 1/3 overlap.

IMPROPER BEAD LAP

Excessive overlap makes the bead too high crowned. Not enough overlap makes a V-shaped depression Slag may be trapped in this area.

(NOTE: The overlapping beads should produce a comparatively smooth surface without noticeable "valleys" between passes.)

H. Continue running beads until pad is full

I. Clean the piece of metal thoroughly and turn in to the instructor for grading

SHIELDED METAL ARC WELDING
UNIT I

JOB SHEET #3--MAKE A SQUARE GROOVE BUTT WELD

I. Equipment and materials

- A. Two pieces of metal 3/16" to 1/4" thick, 2" wide, and 6" long
- B. Welding machines and accessories
- C. Welding helmet
- D. Protective clothing
- E. E-6010--1/8" or 5/32"
  - 1. 1/8" - 75-130 amps
  - 2. 5/32" - 90-175 amps
- F. Current DCRP (+) at the electrode
- G. Safety goggles
- H. Chipping hammer
- I. Wire brush

II. Procedures

A Adjust welding machine to correct welding current

(NOTE: Refer to Chart #1.)

B. Prepare metal for welding by removing dirt, grease, or mill scale

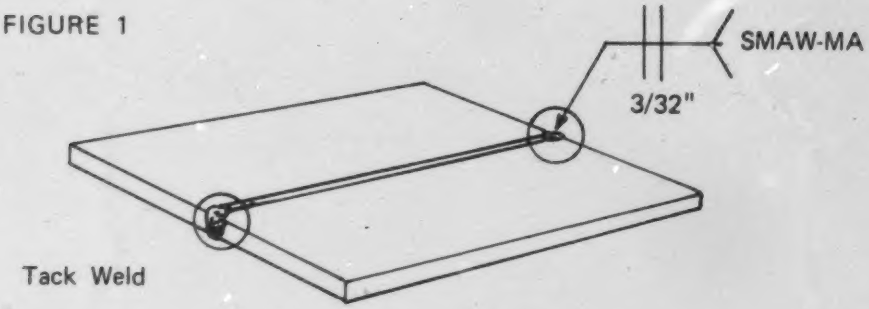
C. Place metal together parallel to each other, leaving a space 3/32"

(NOTE: The proper space can be determined by placing the bare end of a 3/32" electrode between the two pieces of metal.)

JOB SHEET #3

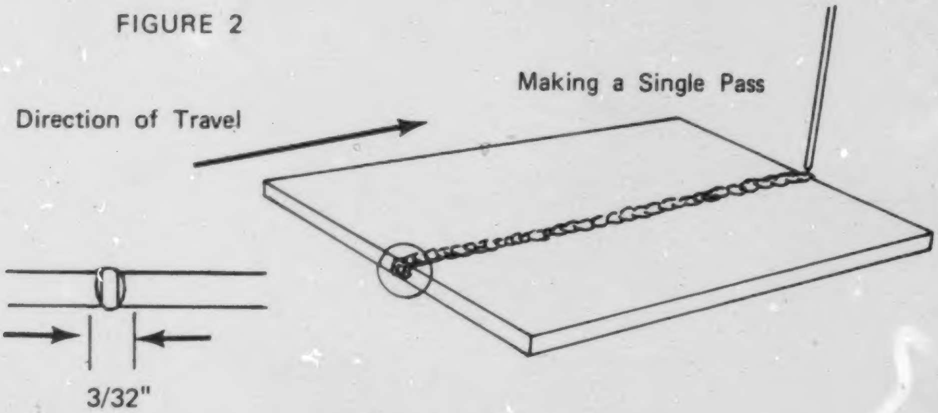
D. Tack weld pieces together at both ends (Figure 1)

FIGURE 1


SMAW-MA
3/32"
Tack Weld

E. Weld pieces together using a single pass on one side for 100% penetration (Figure 2)

FIGURE 2


Making a Single Pass
Direction of Travel
3/32"

F. Chip slag, brush weld, and check for complete penetration at the root of weld

SHIELDED METAL ARC WELDING
UNIT I

TEST

1. Match the terms on the right with the correct definition.

_____a. The exposed surface of a weld, made by an arc or gas welding process on the side from which welding was done

_____b. An arc welding process wherein metals are united by heating with an electric arc between a coated metal electrode and the metal

_____c. A depression at the termination of a weld

_____d. The flow of electric current from the tip of the electrode to the base of the metal being welded

_____e. The distance from the end of the electrode to the point where the arc makes contact with work surface

_____f. Metal rods which conduct a current from the electrode holder to the base metal

_____g. The metal to be welded or cut

_____h. A fusible material or gas used to dissolve and/or prevent the formation of oxides, nitrides, or other undesirable inclusions formed in welding

_____i. That portion of a weld that is molten at the place the heat is supplied

_____j. A weld made to hold parts in proper alignment until the final welds are made

1. Whipping
2. Shielded metal arc welding
3. Weld metal
4. Arc
5. Weaving
6. Electrodes
7. Undercut
8. Base metal
9. Puddle
10. Arc length
11. Tack weld
12. Crater
13. Spatter
14. Face of weld
15. Porosity
16. Flux
17. Pass
18. Low carbon steel
19. AWS
20. Disposition rate

______k. Steel containing .20% or less carbon

______l. The metal particles given off during welding which do not form a part of the weld

______m. A single longitudinal progression of a welding operation along a joint or weld deposit

______n. Gas pockets or voids in metal

______o. A term applied to an inward and upward movement of the electrode which is employed in vertical welding to avoid undercut

______p. A groove melted into the base metal adjacent to the toe of the weld and left unfilled by weld metal

______q. That portion of a weld which has been melted during welding

______r. A technique of depositing weld metal in which the electrode is oscillated

______s. American Welding Society

______t. Amount of filler metal deposited in any welding process; rate is in pounds per hour

2. Name four types of arc welding machines.

a.

b.

c.

d.

3. Name the common equipment needed in shielded metal arc welding.

a.

b.

c.

d.

e.

f.

g.

h.

i.

j.

k.

4. Place an "X" before the statement that signifies reverse polarity.

______a. Current flows from electrode to base metal

______b. Current flows from base metal to electrode

5. Place an "X" before the statement that determines polarity.

______a. Type of flux on electrode

______b. Electrode

______c. Current

______d. Brand of welding machine

6. Name the two types of operating adjustments found on arc welding machines.

a.

b.

7. Discuss in a short paragraph the procedures to follow in testing for polarity.

8. Name four common types of electrodes.

a.

b.

c.

d.

9. Name four common sizes of electrodes.

a.

b.

c.

d.

10. Place an "X" by the statement which determines how electrode size is selected.

_____a. Length of electrode

_____b. Bare end of electrode

_____c. Type of flux on electrode

11. Place an "X" in the blank by the statements which identifies the purposes of flux on electrodes.

_____a. Stabilizes arc

_____b. Makes arc starting difficult

_____c. Shields molten puddle from air

_____d. Provides deoxidizers and scavengers to prevent porosity of weld zone

_____e. Keeps moisture out of filler metal

_____f. Forms slag and slows cooling

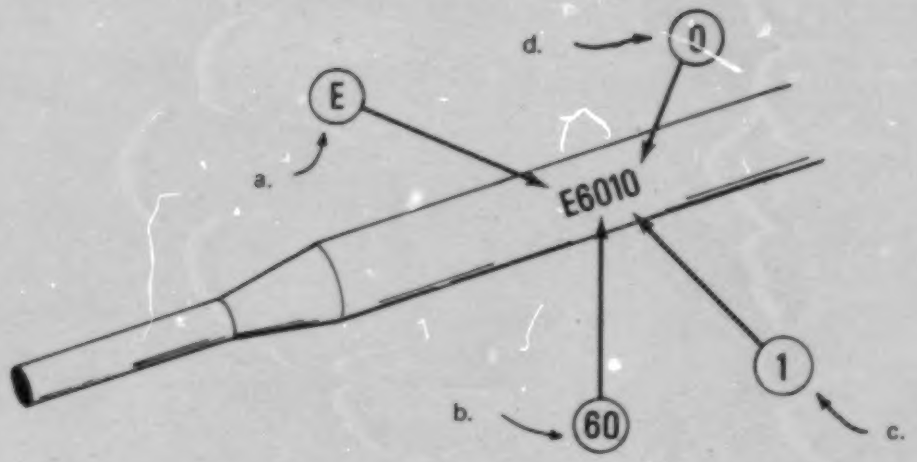
12. Identify the parts of the drawing below.

a.

b.

c.

d.



13. Name five factors to be considered when selecting an electrode.

a.

b.

c.

d.

e.

14. Name four types of welds.

a.

b.

c.

d.

15. Identify the parts of groove and fillet welds in the drawings below.

a.

b.

c.

d.

e.

f. Type of weld

g.

h.

i.

j.

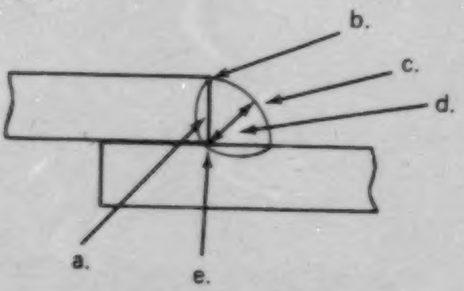
k.

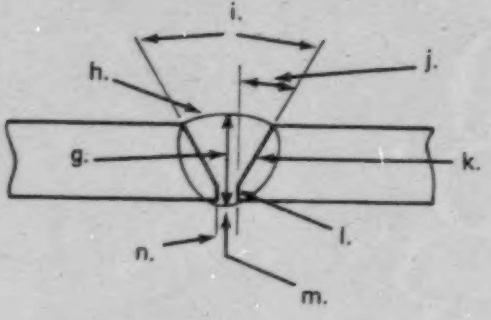
l.

m.

n.

o. Type of weld





16. Identify the types of welding joints.

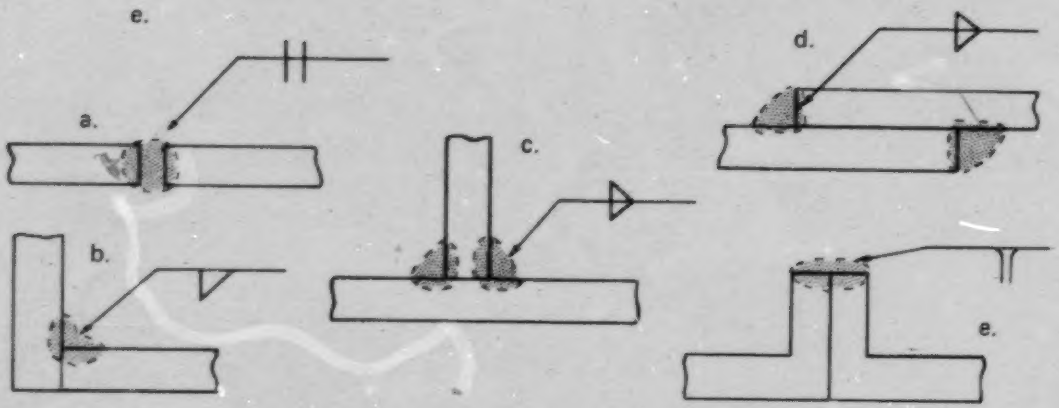
a.

b.

c.

d.

e.



17. Which of the following statements contribute to reasons for poor welds? Place an "X" by your response.

_____a. Improper angle of electrode

_____b. Improper electrode and size

_____c. Improper machine adjustment

_____d. Improper clamping of electrode in holder

_____e. Welding from left to right with the forehand technique

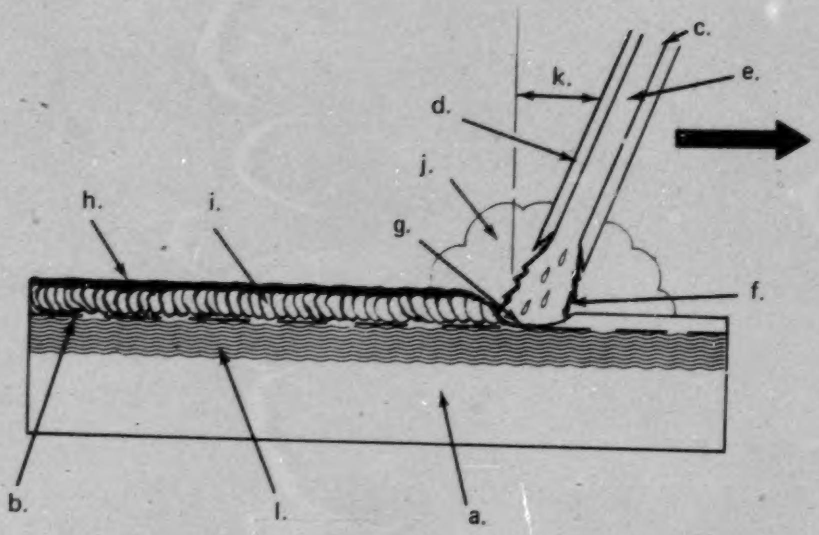
_____f. Improper base metal preparation

_____g. Running a E-6010 electrode on DCRP

_____h. Improper arc length

18. Identify the parts of the welding process illustrated below.

a.
b.
c.
d.
e.
f.
g.
h.
i.
j.
k.
l.



19. Name the two methods of striking an arc.

a.

b.

20. Name five safety precautions to follow in shielded metal arc welding.

a.

b.

c.

d.

e.

21. Match the lens shade number on the right to the type of welding operation. Some of the numbers may be used more than once.

_____a. Gas welding using metal 0 - 1/8 inch thick

_____b. Soldering

_____c. Torch brazing

_____d. Shielded metal arc welding using 1/16, 3/32, 1/8, and 5/32 inch electrodes

_____e. Gas tungsten arc welding nonferrous

_____f. Oxygen cutting using metal 6" and over

1. No. 2
2. No. 3 or 4
3. No. 4 or 5
4. No. 5 or 6
5. No. 6 or 8
6. No. 9 - 14

22. Demonstrate the ability to perform the following tasks:

a. Start, stop, and restart a bead.

b. Strike an arc and construct a pad in flat position, using E-6010 rod, by running uniform beads on mild steel plate which is 1/4" to 3/8" thick.

c. Construct a square groove butt weld on three-sixteenths or one-fourth inch steel plate with one-hundred percent penetration, using a single pass with E-6010 rod.

(NOTE: If the above activities have not been accomplished prior to the test, ask the instructor when they should be completed.)

SHIELDED METAL ARC WELDING
UNIT I

ANSWERS TO TEST

1. a. 14
   b. 2
   c. 12
   d. 4
   e. 10
   f. 6
   g. 8
   h. 16
   i. 9
   j. 11
   k. 18
   l. 13
   m. 17
   n. 15
   o. 1
   p. 7
   q. 3
   r. 5
   s. 19
   t. 20
2. a. AC
   b. AC-DC
   c. Motor generator--Produces DC current
   d. Engine generator--Produces DC current

3. a. Welding machine
   b. Electrode holder with lead
   c. Ground clamp with lead
   d. Shield or helmet
   e. Gloves
   f. Chipping hammer
   g. Safety goggles
   h. Wire brush
   i. Electrodes
   j. Pliers
   k. Protective clothing
4. b
5. a and b
6. a. Current
   b. Polarity
7. The discussion should bring out the two main methods.
   a. Weld a bead using E-6010 reverse polarity electrode
   b. Strike arc with carbon electrode
8. Any four of the following:
   a. Mild steel
   b. Low hydrogen-low alloy
   c. Non-ferrous
   d. Hard surfacing
   e. Cast iron
   f. Stainless steel

9. Any four of the following:
   a. 3/32"
   b. 1/8"
   c. 5/32"
   d. 3/16"
   e. 7/32"
   f. 1/4"
   g. 5/16"

10. b

11. a
    c
    d
    f

12. a. Electrode
    b. Tensile strength deposited in thousand pounds per square inch
    c. Welding position--All positions
       1) All positions
       2) Flat and horizontal
    d. Special characteristics
       1) Current
       2) Penetration
       3) Flux coating

13. Any five of the following:
    a. Base metal strength properties
    b. Base metal composition
    c. Welding position
    d. Welding current
    e. Joint design and fit-up

- f. Thickness and shape of base metal
- g. Service conditions and/or specification
- h. Production efficiency and job conditions

14.
- a. Bead
- b. Fillet
- c. Groove
- d. Plug

15.
- a. Leg
- b. Toe
- c. Face
- d. Throat
- e. Root
- f. Fillet
- g. Throat
- h. Face
- i. Groove angle
- j. Bevel angle
- k. Groove face
- l. Root face
- m. Root
- n. Root opening
- o. Groove

16.
- a. Butt
- b. Corner
- c. Tee
- d. Lap
- e. Edge

17. a

    b

    c

    f

    h

18. a. Base metal

    b. Penetration

    c. Electrode

    d. Coating

    e. Wire core

    f. Arc

    g. Crater

    h. Slag

    i. Weld

    j. Gaseous shield

    k. Ten degrees--fifteen degrees

    l. Heat lines

19. a. Tapping

    b. Scratching

20. Any five of the following:

    a. Keep equipment in good, clean, dry condition

    b. Make sure all electrical connections are tight, clean, and dry

    c. Use correct size welding cable--Do not overload

    d. Be sure cables, holder, and connections are properly insulated

    e. Cut off power to welder before cleaning machine or making internal adjustments

    f. Never change polarity or current settings while machine is under load

g. Observe normal operating care for electrical hazards

h. Keep work area neat, clean, and dry

i. Remove flammable materials from welding area, or shield them

j. Do not weld near volatile, flammable liquids or gases

k. Do not weld or cut on containers such as drums, barrels, or tanks until you know there is no danger of fire or explosion

l. Dispose of hot electrode stubs in a metal container

m. Never strike an arc on a compressed gas cylinder

n. Protect your eyes from rays of the arc; wear a headshield with the proper filter plates when welding or cutting

o. Wear protective chipping goggles when chipping off weld slag

p. Wear leather gloves and protective clothing such as an apron, sleeves, etc. to shield against the arc rays and sparks; button up shirt collar

q. Use a non-reflecting welding curtain to protect others in the area from the arc rays

r. Be sure work area has adequate ventilation-plenty of fresh air; special precautions are necessary when welding lead, zinc, beryllium copper, or cadmium

s. Do not pick up hot metal

t. Always open main switch or disconnect plug when checking over a welder

u. Do not leave electrode holder on welding table or in contact with grounded metal surface

v. Keep tools and metal in their proper locations

21. a. 3

b. 1

c. 2

d. 6

e. 6

f. 4

22. Performance skills will be evaluated to the satisfaction of the instructor.

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to deposit beads in the flat, horizontal, vertical, and overhead positions using E-6010 and E-7018 electrodes. He should be able to construct test plates in all positions that will withstand a root and face bend and tensile test. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with shielded metal arc welding to the correct definition.
2. Name four factors that determine proper machine adjustment.
3. Name the four welding positions.
4. Select reasons for removing slag from a weld.
5. Name three reasons for fusing one bead in with another.
6. Name four factors that determine weld quality.
7. Identify properly and improperly formed beads by telling what caused each one.
8. Name two causes and two solutions to prevent arc blow.
9. Identify the different types of groove joints.
10. Demonstrate the ability to:
    a. Build a pad in the horizontal position.
    b. Construct a multiple pass T-joint in the horizontal position.
    c. Weld a square groove butt weld in the horizontal position.
    d. Build a pad in the vertical up position.
    e. Make a T-joint in the vertical up position.

f. Make a square groove butt joint in the vertical down position.

g. Build a pad in the overhead position.

h. Make a lap joint in the overhead position.

i. Lay out, cut, and prepare weld coupons for testing.

j. Test weld coupons.

k. Make a single V-groove joint in the flat position and test.

l. Make a single V-groove joint in the horizontal position and test.

m. Make a single V-groove joint in the vertical up position and test.

n. Make a single V-groove joint in the overhead position and test.

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

   A. Provide students with objective sheet.

   B. Provide students with information and job sheets.

   C. Discuss terminal and specific objectives.

   D. Discuss information sheet.

   E. Demonstrate and discuss procedures outlined in the job sheets.

   (NOTE: On each job sheet E-7018 electrodes may be substituted for E-6010.)

   F. Give test.

II. Students:

   A. Read objective sheet.

   B. Study information sheet.

   C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

   D. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

   A. Objectives

   B. Information sheet

   C. Transparencies

      1. TM 1a and 1b--Weld Test Positions

      2. TM 2--Properly and Improperly Formed Beads

      3. TM 3--Types of Groove Joints

D. Job sheets

1. Job Sheet #1--Make a Pad in the Horizontal Position
2. Job Sheet #2--Make a Multiple Pass T-Joint Fillet Weld in the Horizontal Position
3. Job Sheet #3--Make a Square Groove Butt Joint Weld in the Horizontal Position
4. Job Sheet #4--Make a Pad in the Vertical Up Position
5. Job Sheet #5--Make a T-Joint Fillet Weld in the Vertical Up Position
6. Job Sheet #6--Make a Square Groove Butt Joint Weld in the Vertical Down Position
7. Job Sheet #7--Make a Pad in the Overhead Position
8. Job Sheet #8--Make a Lap Joint Fillet Weld in the Overhead Position
9. Job Sheet #9--Weld Testing-Lay Out, Cut, and Prepare Coupons
10. Job Sheet #10--Test the Prepared Coupon
11. Job Sheet #11--Make a Single V-Groove Butt Weld in the Flat Position and Test
12. Job Sheet #12--Make a Single V-Groove Butt Weld in the Horizontal Position and Test
13. Job Sheet #13--Make a Single V-Groove Butt Weld in the Vertical Up Position and Test
14. Job Sheet #14--Make a Single V-Groove Butt Weld in the Overhead Position and Test

E. Test

F. Answers to test

II. References:

A. *New Lessons in Arc Welding.* Cleveland 17, Ohio: The Lincoln Electric Company.

B. *Hobart Welding School Workbook.* Troy, Ohio: Hobart School of Welding Technology.

C. *The Welding Encyclopedia.* Sixteenth Edition. The Welding Engineer Publishing Company. Morton Grove, Illinois: Monticello Books.

D. *Welding Handbook*. Sixth Edition. Miami, Florida: American Welding Society.

E. Pierre, Ed R. *Welding Processes and Power Sources Study Guide and Workbook*. Appleton, Wisconsin: Miller Electric Manufacturing Company.

F. *Welding Skills and Practices.* Third Edition. Chicago, Illinois: American Technical Society.

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Pad--A series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer

B. Horizontal position--The running of a horizontal bead on a vertical surface

C. Vertical position--The beads are deposited in a vertical position on a vertical surface; axis of weld is vertical

D. Weld face--The exposed surface of a fusion weld

E. Root--The bottom surface of a weld on the opposite side from which welding was done

F. Penetration--The distance from the original surface of the base metal to that point at which fusion ceases

G. Undercutting--The portion of the crater left unfilled due to excessive current and the improper movement of the electrode occurring at the edge of the bead

H. Crater--A depression in the face of a weld caused by arc force; usually found at the end of a bead

I. Fusion--The melting of metals until the molten portions unite with each other

J. Overhead position--The position of welding wherein welding is performed from the underside of the joint

K. String bead--A weld bead made with very little rod manipulation

L. Root opening--The gap between the members to be joined at the root of the joint

M. Porosity--A condition caused by a trapped gas pocket in a weld as it solidifies

N. Slag inclusion--Non-metallic porous material entrapped in weld metal or between the weld metal and base metal

O. Cold lap--A piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld

INFORMATION SHEET

- P. Arc blow--A concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path
- Q. Coupon--That portion of a weld which is removed from the test plate to test for strength

II. Factors determining proper machine adjustment

- A. Length of welding cables
- B. Thickness of base metal
- C. Diameter and type of electrode
- D. Welding technique used by operator
- E. Efficiency of welding machine and polarity
- F. Welding position

III. Welding positions (Transparencies 1a and 1b)

- A. Flat
- B. Vertical
- C. Overhead
- D. Horizontal

IV. Reasons for removing slag

- A. Permits better fusion of beads
- B. Prevents gas pockets and slag inclusions from forming in bead
- C. Improves appearance of bead

V. Reasons for fusing one bead in with another

- A. Increases strength of weld
- B. Improves appearance of bead
- C. Improves penetration

VI. Factors that determine weld quality

- A. Amperage
- B. Length of arc
- C. Speed of travel
- D. Position of electrode

INFORMATION SHEET

VII. Causes of properly and improperly formed beads (Transparency 2)

  A. Current, voltage, and speed normal--Smooth well-formed bead with no undercutting, overlapping, or piling of slag

  B. Current low--Poor penetration, slow progress, excessive piling of weld metal

  C. Current high--Excessive sputter, undercutting of weld joints

  D. Voltage high--Poor penetration with flat bead, weld zone not shielded

  E. Voltage low--Poor penetration, wide humped bead, electrode too close to crater causing porosity

  F. Speed slow--Excessive heat, piling up of weld metal leading to unnecessary distortion of joint

  G. Speed fast--Irregular bead, poor penetration, not enough weld metal in joint causing a weak joint

VIII. Arc blow

  A. Causes

    1. Magnetic forces present with DC current build up lines of magnetism around the arc causing it to be unstable with excessive spatter

    2. High amperage, thick plates, corners, deep grooves, and the start and finish of joints are the major problem areas

  B. Solutions

    1. Reduce current or switch polarity

    2. Change current to AC

    3. Change location of ground clamp

    4. Wrap ground cable around work piece and pass ground current through it to neutralize magnetic field

    5. Maintain a short arc

IX. Types of groove joints (Transparency 3)

  A. Square

  B. J-groove

  C. Single bevel

INFORMATION SHEET

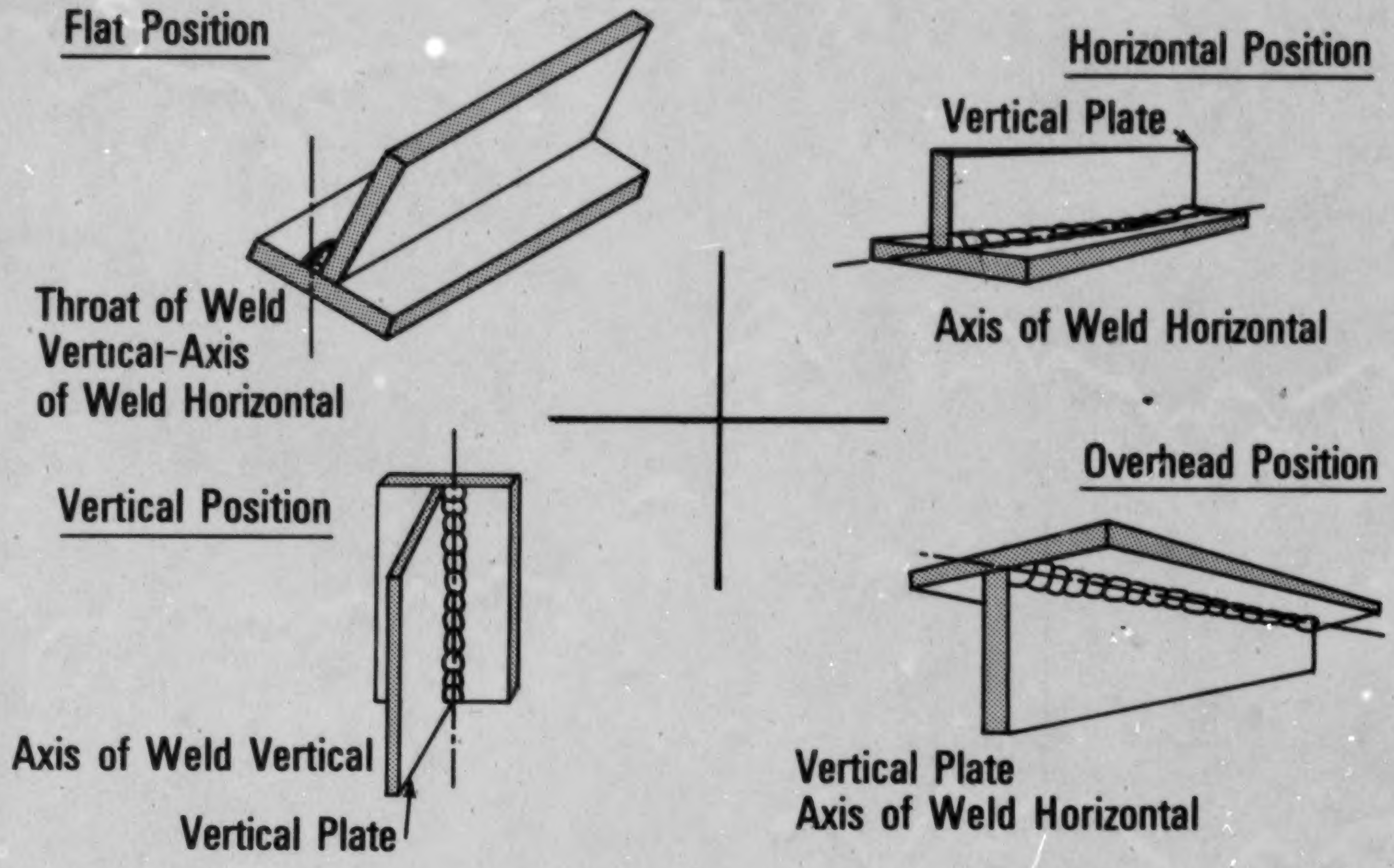
D. Single V

E. Double bevel

F. U-groove

Weld Test Positions

FILLET WELDS



Flat Position

Throat of Weld
Vertical-Axis
of Weld Horizontal

Horizontal Position

Vertical Plate

Axis of Weld Horizontal

Vertical Position

Axis of Weld Vertical

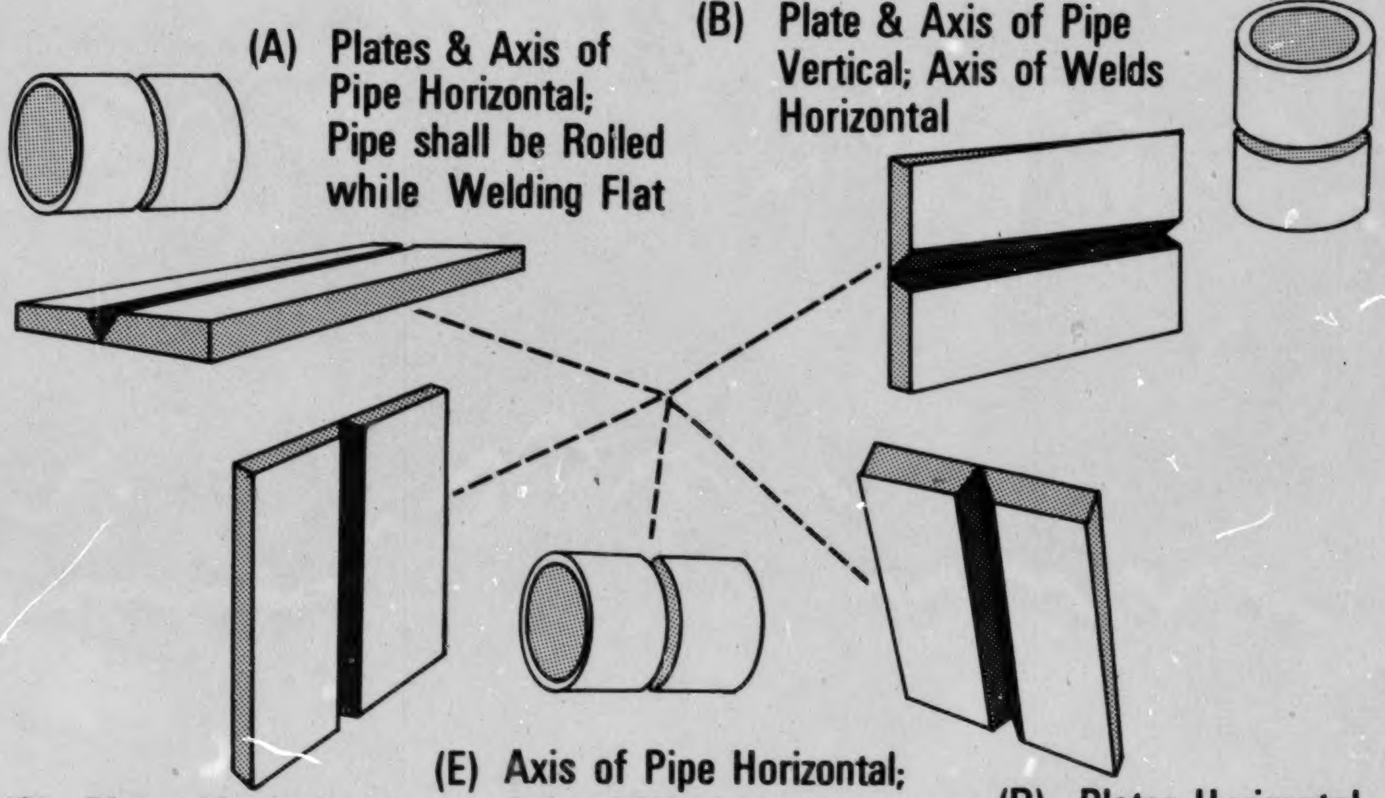
Vertical Plate

Overhead Position

Vertical Plate
Axis of Weld Horizontal

Weld Test Positions

GROOVE WELDS



(A) Plates & Axis of Pipe Horizontal; Pipe shall be Rolled while Welding Flat

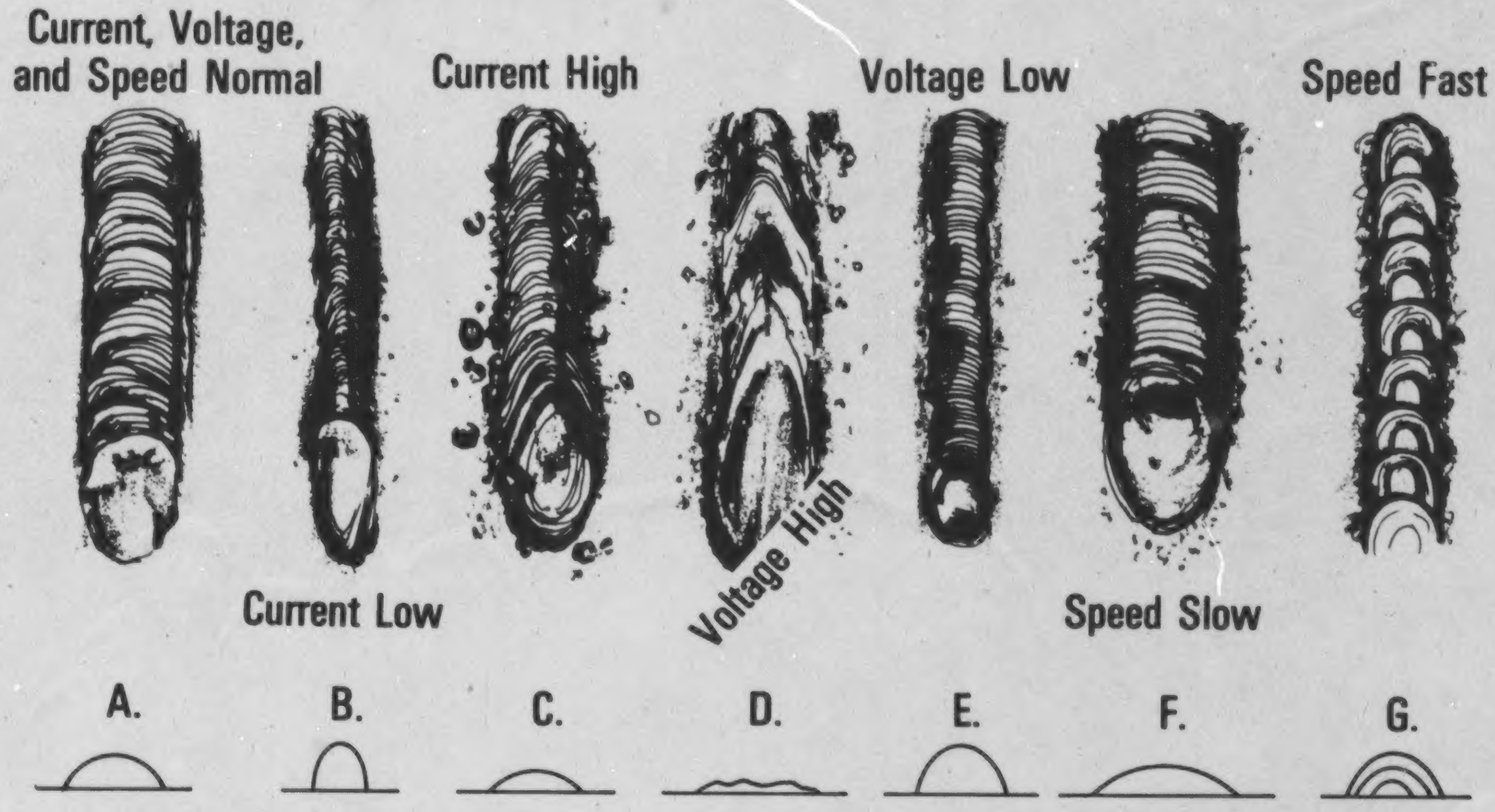
(B) Plate & Axis of Pipe Vertical; Axis of Welds Horizontal

(C) Plates Vertical Axis of Weld Vertical

(E) Axis of Pipe Horizontal; Axis of Weld Vertical

(D) Plates Horizontal; Axis of Weld Horizontal

Properly and Improperly Formed Beads

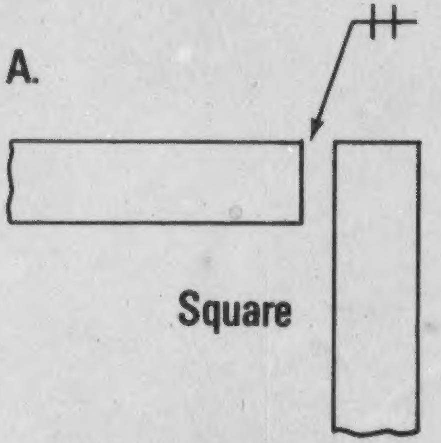

Current, Voltage, and Speed Normal
Current Low
Current High
Voltage High
Voltage Low
Speed Slow
Speed Fast
A.
B.
C.
D.
E.
F.
G.

TM 2

63-E

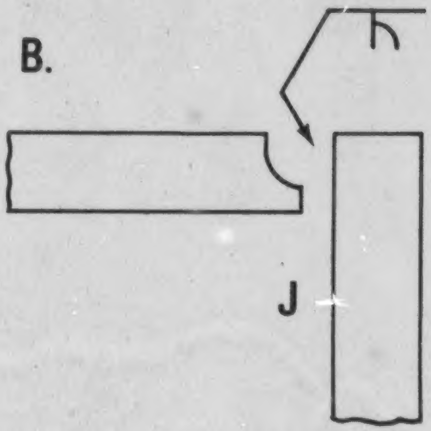
Types of Groove Joints

A.



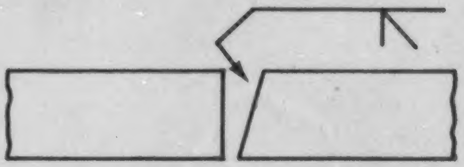
Square

B.



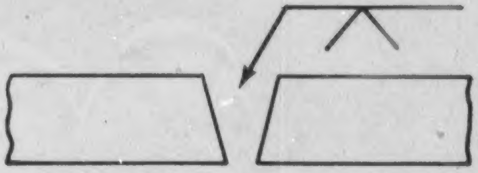
J

C.



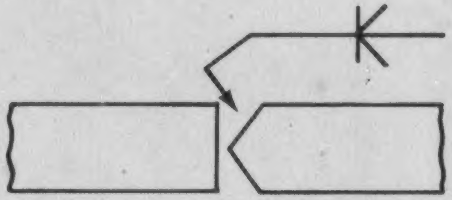
Single Bevel

D.



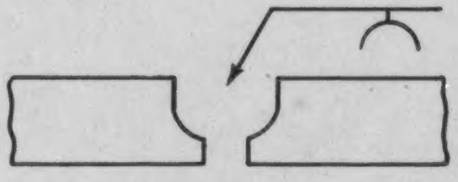
Single V

F.



Double Bevel

E.



U

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #1--MAKE A PAD IN THE HORIZONTAL POSITION

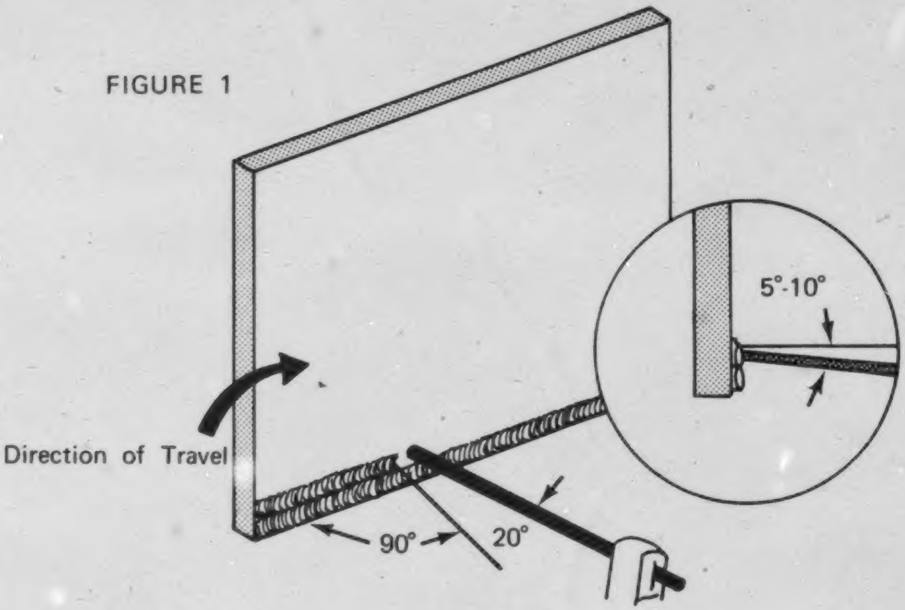
I. Equipment and materials

- A. Arc welding station and required tools
- B. Protective clothing
- C. E-6010 electrodes 1/8" or 5/32"
    - 1. 1/8" - 75-130 amps
    - 2. 5/32" - 90-175 amps
- D. Current DCRP + at electrode
- E. Mild steel plate 3/8" thick, 6" by 6"

II. Procedure

- A. Adjust machine to correct type and amount of current
- B. Position metal in horizontal position for welding and tack
- C. Position electrode down 5°-10° and angled 20° in direction of travel (Figure 1)

FIGURE 1



JOB SHEET #1

D. Strike arc and hold high arc length 1-2 seconds in lower left hand corner welding to the lower right hand corner

(NOTE: Some type of manipulation of the rod will be helpful.)

(CAUTION: Care should be taken to hold center of bead from 1/8" to 3/16" from bottom edge to avoid burning edge off.)

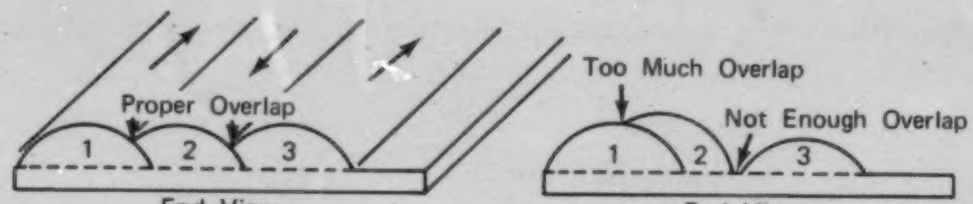
E. After laying first bead, chip and brush weld clean, and check weld surface for pinholes and slag inclusions

(NOTE: Crater at end of bead should be filled.)

F. Continue running beads overlapping at least the first one-third of the previous bead until pad is filled (Figure 2)

(NOTE: Alternate travel direction for each pass.)

FIGURE 2



End View
Proper Bead Lap

End View
Improper Bead Lap

(NOTE: Clean each pass thoroughly before overlapping with another to insure a sound weld deposit with proper penetration. Each pass should fuse with the base metal as well as with the preceding pass.)

G. Clean the pad and turn it in for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #2--MAKE A MULTIPLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION

I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plate-2 pieces 1/4" to 3/8", 3" x 6"
- C. Electrode E-6010 1/8" or 5/32"
  - 1. 1/8" - 75-130 amps
  - 2. 5/32" - 90-175 amps
- D. Current DCRP + at electrode
- E. Protective clothing

II. Procedure

- A. Adjust welding machine to correct current and amperage
- B. Position plates on table to form a T-joint
- C. Tack plates on each end and slag
- D. For first bead, angle electrode 45° from vertical plate and 5-10° in direction of travel (Figure 1)

Multiple Pass Fillet Weld

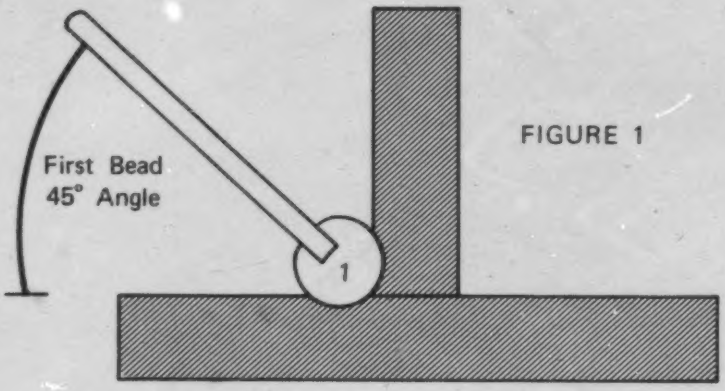


FIGURE 1

JOB SHEET #2

E. Strike arc at end of plate holding a high arc for 1 or 2 seconds

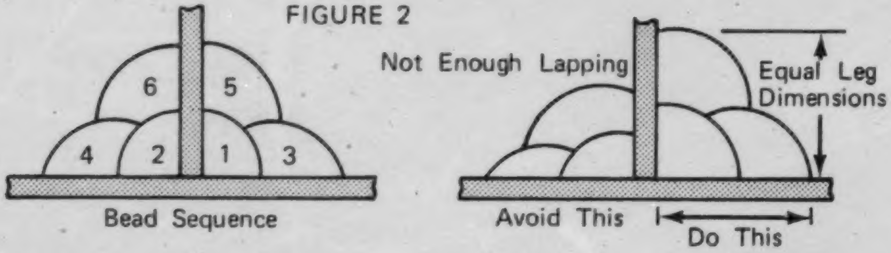
(NOTE: This allows for the end of the metal plates to heat prior to depositing the proper beads and prevents cold lap.)

F. Move electrode to opposite side of T-joint and start depositing second bead using same angle used in bead one

G. Deposit beads about two times wider than electrode diameter

(NOTE: Remember to alternate passes from one side to another of T-joint to minimize distortion of the plates.) (Figure 2)

FIGURE 2



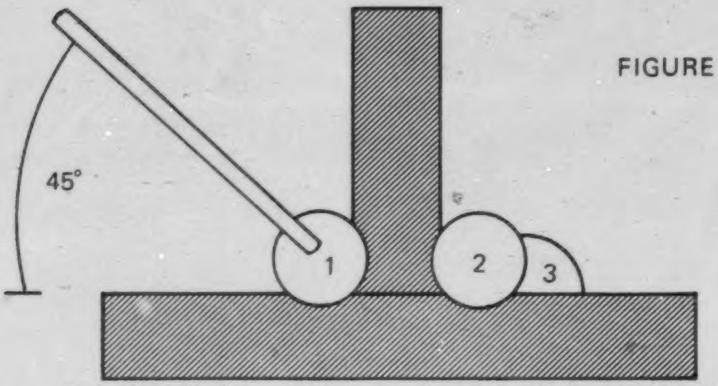
Keep Bead Dimensions Constant

H. Remove slag from bead one and two

(NOTE: Keep each bead dimension constant. It is necessary to overlap beads more than seems necessary to avoid laying too much metal on bottom by side of joint.)

I. Deposit bead three using a 30° degree angle from vertical plate with the electrode slanting 5 to 10° in direction of travel (Figure 3)

FIGURE 3



Deposit Beads on Alternate Sides to Minimize Distortion

JOB SHEET #2

J. Deposit bead four using same angle as used in depositing bead three (Figure 4)

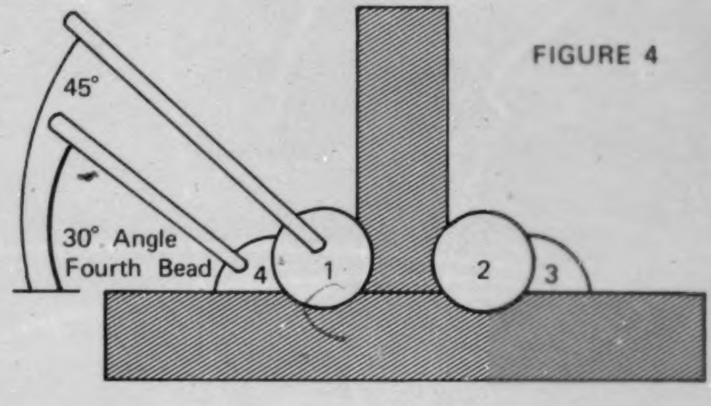

45°
30° Angle
Fourth Bead
4
1
2
3

FIGURE 4

K. Deposit bead five using a 70° degree angle from vertical plate with the electrode slanting 5 to 10° in direction of travel (Figure 5)

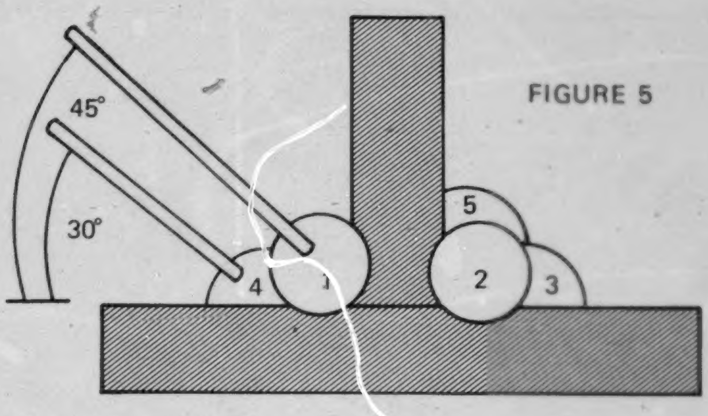


FIGURE 5

L. Deposit bead six using same angle as used in bead five (Figure 6)

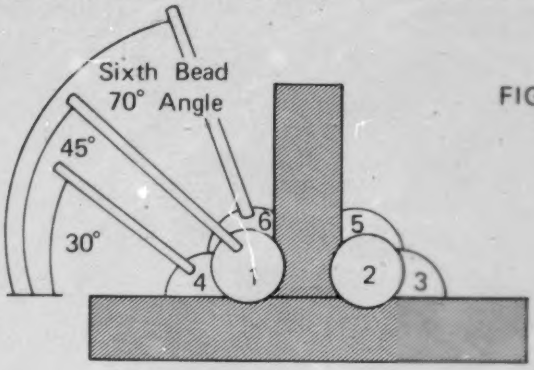
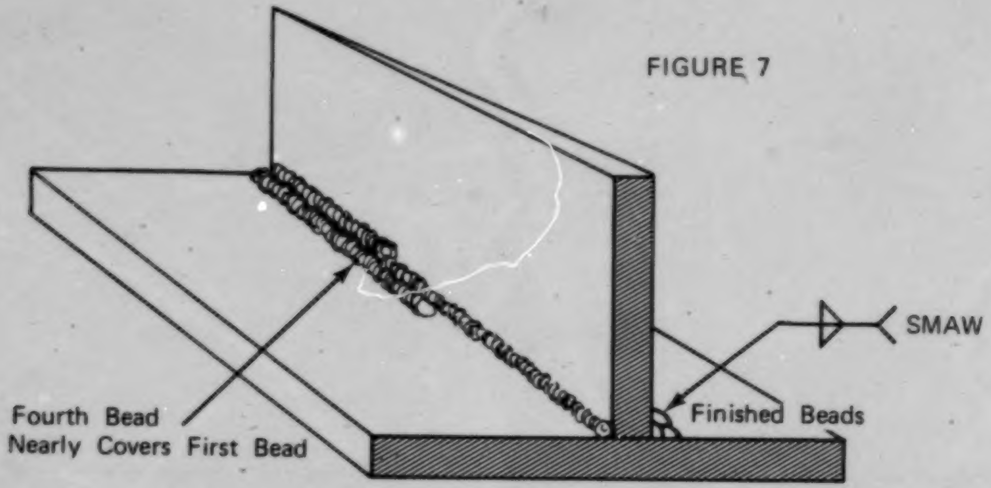

Sixth Bead
70° Angle
45°
30°
6
4
1
5
2
3

FIGURE 6

JOB SHEET #2

M. After completing required number of passes, turn plate in for instructor's approval (Figure 7)

FIGURE 7


SMAW
Finished Beads
Fourth Bead
Nearly Covers First Bead

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #3--MAKE A SQUARE GROOVE BUTT JOINT WELD IN THE HORIZONTAL POSITION

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel plate-2 pieces 3/16" x 2" x 6"

   C. Electrode E-6010 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at electrode

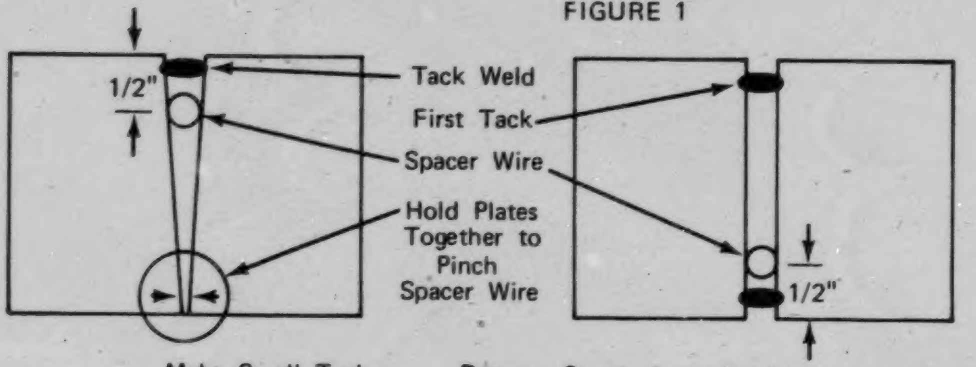
   E. Protective clothing

II. Procedure

   A. Adjust machine to correct current and amperage setting

   B. Position material vertically and tack weld leaving a 1/16"-1/8" groove (root gap) between plates (Figure 1)

FIGURE 1


1/2"
Tack Weld
First Tack
Spacer Wire
Hold Plates Together to Pinch Spacer Wire
1/2"

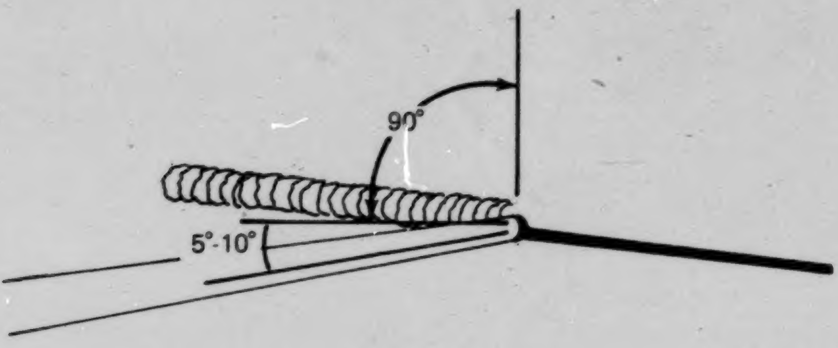
Make Small Tacks

Remove Spacer Immediately

JOB SHEET #3

C. Angle electrode straight into joint 90° with both plates and tilted 5° to 10° in direction of travel (Figure 2)

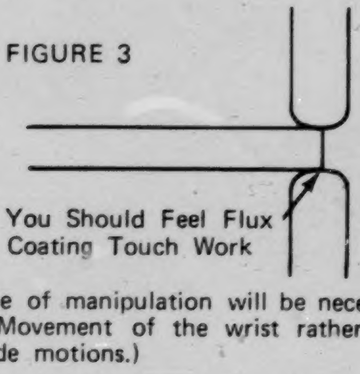
FIGURE 2



D. Strike and hold a high arc for 1 or 2 seconds to heat plates

E. Deposit bead using a short arc placing electrode into joint about 1/3 thickness of material (Figure 3)

FIGURE 3



(NOTE: Some type of manipulation will be necessary to control puddle and penetration. Movement of the wrist rather than the arm aids in controlling electrode motions.)

JOB SHEET #3

F. Check root of weld on reverse side to determine extent of penetration (Should be 100%); remove all slag and deposit a second bead on reverse side

G. After cleaning plate, turn in for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #4--MAKE A PAD IN THE VERTICAL UP POSITION

I. Equipment and materials

A. Arc welding station and required tools

B. Mild steel plates 3/8" thick, 6" by 6"

C. Electrodes E-6010 1/8" or 5/32"

1. 1/8" - 75-130 amps

2. 5/32" - 90-175 amps

D. Current DCRP + at 1/8" electrode 75-130 amps

E. Protective clothing

II. Procedure

A. Adjust machine to correct type and amount of current

B. Prepare and tack metal in a vertical position

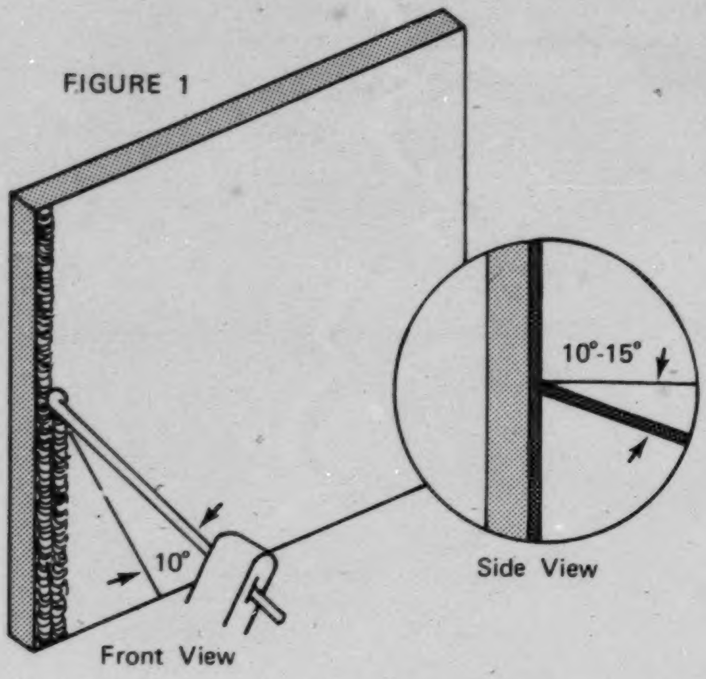
(NOTE: Vertical up welding has deeper penetration than the vertical down; this technique is usually reserved for thicker metals and requires lower amperage settings.)

C. Position electrode at 90° angle to plate and tip down from horizontal 10-15° for first bead

JOB SHEET #4

D. All other beads require at 10^{0} side angle with each previously laid bead with the $10\text{-}15^{0}$ angle down from horizontal remaining the same (Figure 1)

FIGURE 1



E. Strike an arc on the lower left hand corner of plate, hold high arc length 1 to 2 seconds and start welding upward to top of plate

(NOTE: A slight manipulation of the rod tip will be necessary.)

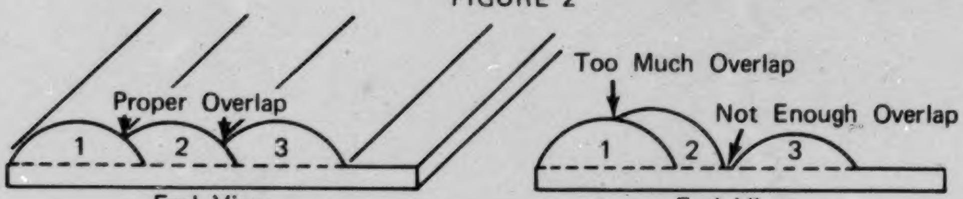
F. After laying first bead, chip and brush weld clean, and check surface for porosity and slag inclusions

(NOTE: Crater at end of each pass should be filled.)

JOB SHEET #4

G. Deposit additional beads overlapping each at least 1/3 until pad is filled (Figure 2)

FIGURE 2


Proper Overlap
1
2
3
Too Much Overlap
Not Enough Overlap
1
2
3

End View
Proper Bead Lap

End View
Improper Bead Lap

H. After a complete layer of passes have been applied, clean thoroughly and turn in to instructor for evaluation

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #5--MAKE A T-JOINT FILLET WELD IN THE VERTICAL UP POSITION

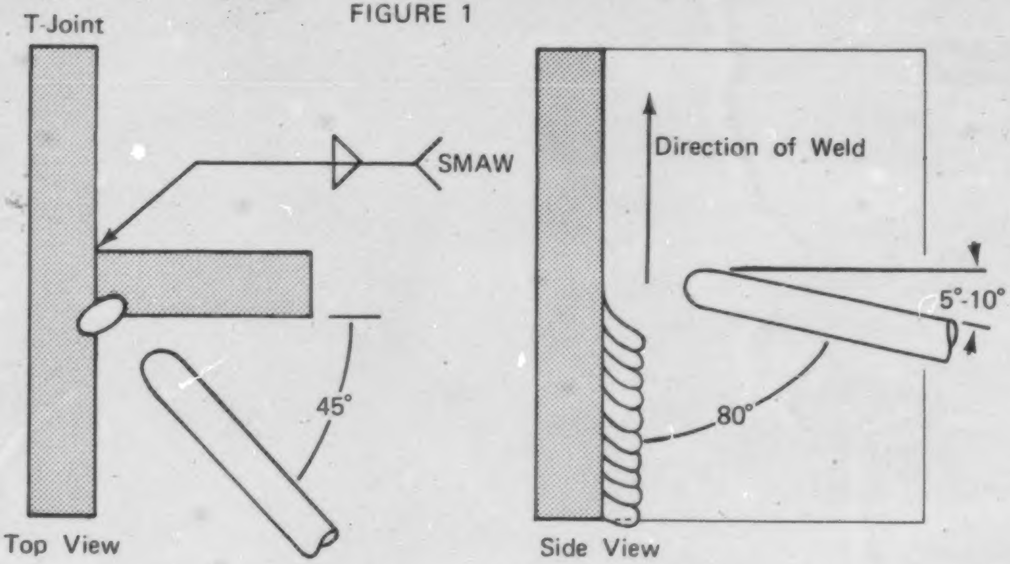
I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plate 1/4" - 3/8", two pieces 2" x 6"
- C. Electrode E-6010 1/8" or 5/32"
  - 1. 1/8" - 75-130 amps
  - 2. 5/32" - 90-175 amps
- D. Current DCRP + at 1/8" - 75-130 amps
- E. Protective clothing

II. Procedure

- A. Adjust welding machine to correct current and amperage setting
- B. Prepare and tack metal in vertical position--slag tacks
- C. Strike arc at bottom of joint and hold a high arc length for 1 or 2 seconds to heat plates
- D. Position electrode in middle of joint making a 45° angle with each plate, and 5-10° down from horizontal (Figure 1)

FIGURE 1



Electrode Position of Vertical Up T-Joint

JOB SHEET #5

E. Deposit weld upward using some form of up and down whipping motion

(NOTE: Bead uniformity depends upon proper timing and manipulation of electrode. Check with instructor for correct procedures.)

F. Remove slag and clean thoroughly after every pass

G. Alter sides to minimize distortion

(NOTE: Check with instructor at this point. Upon receiving instructor's approval, additional beads may be stringers or some form of weave bead.)

H. After completing exercise, turn in plate for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #6--MAKE A SQUARE GROOVE BUTT JOINT WELD IN THE VERTICAL DOWN POSITION

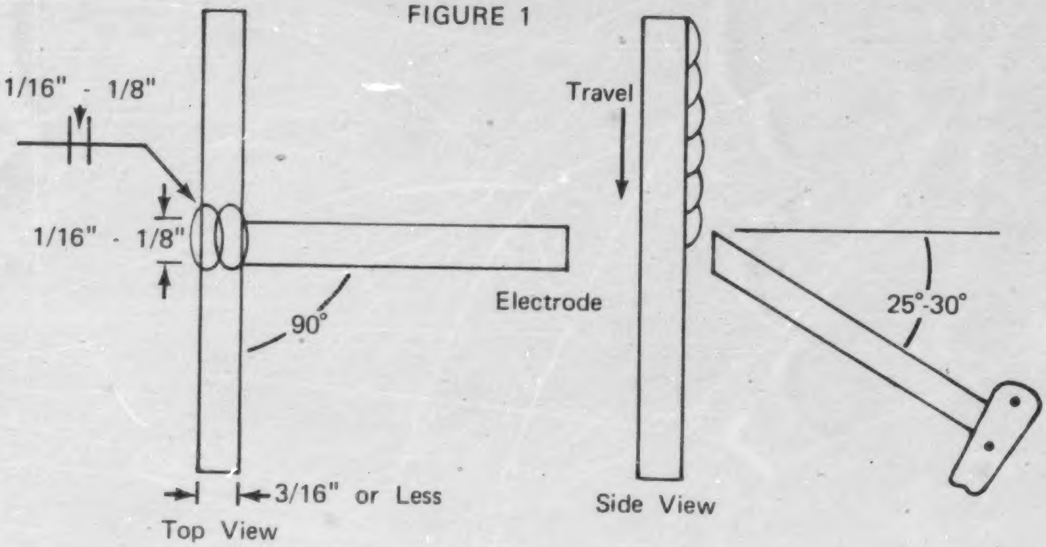
I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plates 1/8" or 3/16", 2 pieces 3" x 6"
- C. Electrode E-6010 1/8" or 5/32"
  - 1. 1/8" - 75-130 amps
  - 2. 5/32" - 90-175 amps
- D. Current DCRP + at the electrode
- E. Protective clothing

II. Procedure

- A. Adjust welding machine to correct current and amperage setting
- B. Prepare and tack metal leaving a 1/6" - 1/8" root gap in vertical position
- C. Position electrode straight into middle of joint and down 25° - 30° from horizontal (Figure 1)

FIGURE 1



JOB SHEET #6

D. Strike arc at top of plates, hold a high arc length for 1 or 2 seconds to heat plates and prevent cold laps

E. Weld down holding a short arc length with some form of whipping motion

F. Remove all slag from face and root and inspect bead thoroughly for penetration and even fusion with both plates

G. Start at the top of the reverse side and run second bead using the same technique as in first pass

H. After cleaning and inspecting, turn in for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #7–MAKE A PAD IN THE OVERHEAD POSITION

I. Equipment and materials

- A. Arc welding station and required tools
- B. Mild steel plate 1/4" or 3/8", two pieces 6" x 6"
- C. Electrode E-6010 1/8" or 5/32"
    - 1. 1/8" - 75-130 amps
    - 2. 5/32" - 90-175 amps
- D. Protective clothing

II. Procedure

- A. Adjust welding machine to correct current and amperage setting
- B. Prepare and tack metal in the overhead position

  (NOTE: Metal will be in horizontal position with floor.)
- C. Strike arc at edge of plate; hold a high arc for one or two seconds to heat up base metal

  (CAUTION: Avoid depositing first bead too close to edge of plate.)
- D. Hold electrode perpendicular to plate with a 0 to 15° in direction of travel (Figure 1)

Overhead Welding

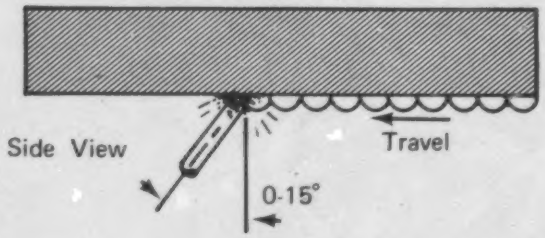
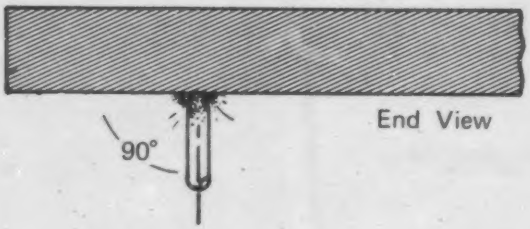


FIGURE 1



JOB SHEET #7

(NOTE: Metal should be deposited with a very short arc. A slight whipping motion may be helpful in controlling bead shape.)

E. Start at the end of plate and progress across plate

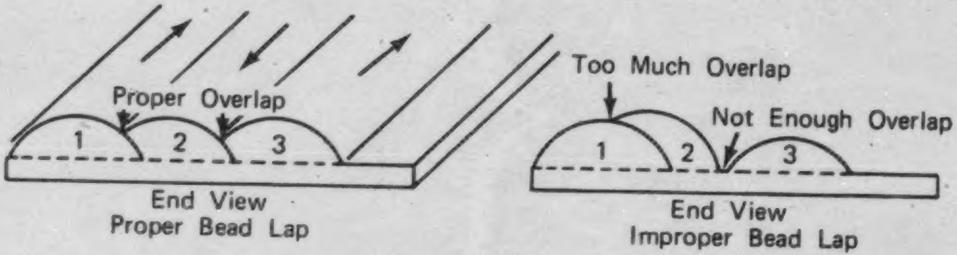
(NOTE: After completion of each bead thoroughly chip and brush the weld checking for bead appearance which will determine if current, amps, or welding technique needs to be changed.)

F. Deposit additional beads until plate is completely covered

(NOTE: Each additional bead should be overlapped about 1/3 of previous bead. Bead should have a smooth surface without noticeable "valleys" or "trapped slag.") (Figure 2)

(NOTE: Alternate travel direction for each pass.)

FIGURE 2


Proper Overlap
1
2
3
End View
Proper Bead Lap
Too Much Overlap
Not Enough Overlap
1
2
3
End View
Improper Bead Lap

G. After completing the required layer of passes, clean pad and turn in for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #8--MAKE A LAP JOINT FILLET WELD IN THE OVERHEAD POSITION

I. Equipment and materials

  A. Arc welding station and required tools

  B. Mild steel plate two pieces 1/4" - 3/8", 2" x 6"

  C. Electrode E-6010, 1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  D. Current DCRP + at electrode

  E. Protective clothing

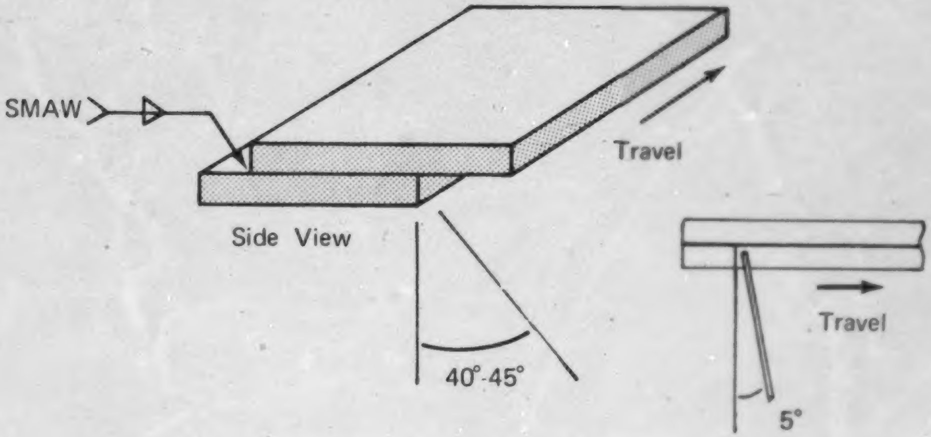
II. Procedure

  A. Adjust welding machine to correct current and amperage setting

  B. Prepare and tack plate together for a 90° lap joint in the overhead position

  C. Position electrode 40°-45° out from vertical and inclined 5° in direction of travel (Figure 1)

FIGURE 1



JOB SHEET #8

D. Strike arc and establish a puddle evenly on both pieces

(NOTE: Be sure and get good penetration into root of joint without undercutting or overlapping plates. Some form of whipping motion will be needed.)

E. After depositing first bead, (root pass) the weld should be chipped, brushed clean, and checked for bead appearance

F. Deposit additional beads if necessary as stringers or weaves

G. After completing this exercise, clean plates and turn in for instructor's approval

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #9--WELD TESTING-LAY OUT, CUT, AND PREPARE COUPONS

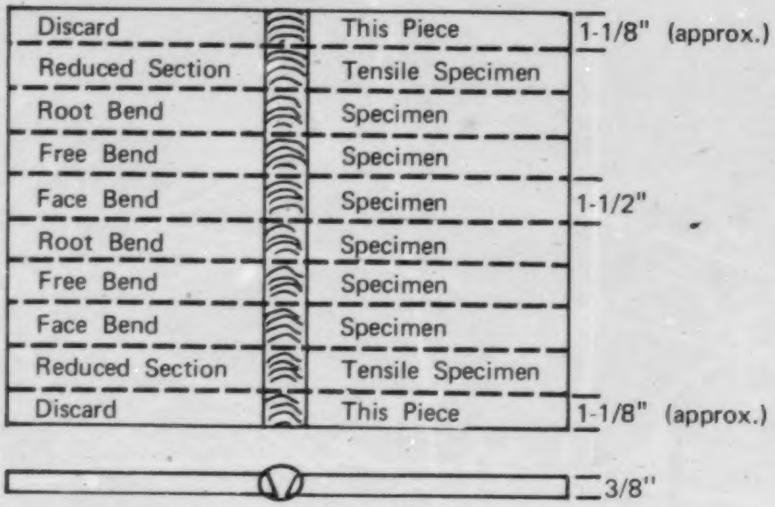
I Equipment and materials

- A. Lay out tools
  - 1. Soapstone
  - 2. Steel rule
  - 3. Steel number and letter stencils
  - 4. Hammer
- B. Power hacksaw
- C. Milling machine (if available)
- D. Oxyacetylene cutting unit
- E. Grinder, portable right angle and pedestal
- F. Protective equipment

II. Procedure

- A. Lay out test plate as indicated in Figure 1

FIGURE 1


Discard
This Piece
1-1/8" (approx.)
Reduced Section
Tensile Specimen
Root Bend
Specimen
Free Bend
Specimen
Face Bend
Specimen
1-1/2"
Root Bend
Specimen
Free Bend
Specimen
Face Bend
Specimen
Reduced Section
Tensile Specimen
Discard
This Piece
1-1/8" (approx.)
3/8"

JOB SHEET #9

B. When flame cutting, allow enough metal for finished size after grinding or machining of 1 1/2" width and a minimum of 6" in length

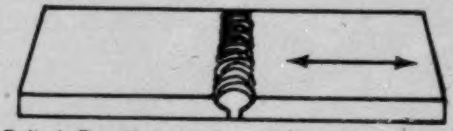
(NOTE: At no time shall coupon be cooled rapidly as this may cause failure when tested.)

C. For best test results, the coupon should be finished in the following manner for root and face bend

1. Grind to a smooth flush finish

(NOTE: Grind marks should run the length of the coupon, not across.) (Figure 2)

FIGURE 2



Grind Parallel to Length of Test Strips

2. A slight radius should be ground on all four corners running the full length of coupon--A 1/16" radius is maximum (Figure 3)

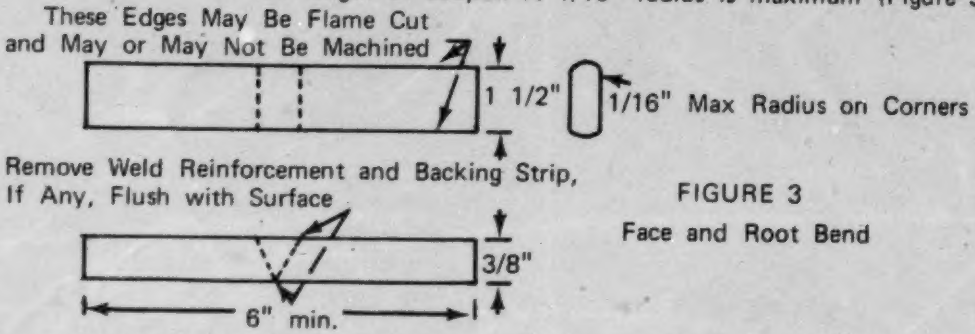

These Edges May Be Flame Cut
and May or May Not Be Machined
1 1/2"
1/16" Max Radius on Corners
Remove Weld Reinforcement and Backing Strip,
If Any, Flush with Surface
3/8"
6" min.

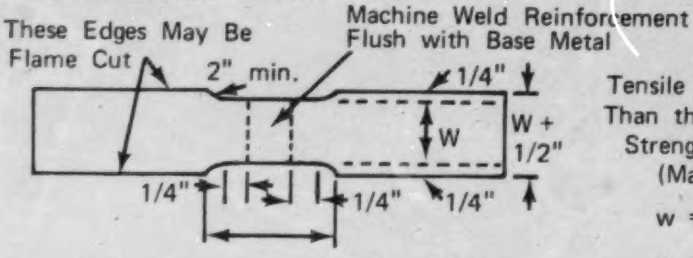
FIGURE 3

Face and Root Bend

D. Reduced section tensile is cut and prepared as indicated (Figure 4)

FIGURE 4

Reduced Section Tensile


These Edges May Be
Flame Cut
Machine Weld Reinforcement
Flush with Base Metal
2" min.
1/4"
W
W +
1/2"
1/4"
1/4"
1/4"

Tensile Strength Shall Not Be Less Than the Minimum Specified Tensile Strength of the Base Metal Used (May Break in the Weld)

w = 1-1/2" if t ≦ 1"

w = 1" if t > 1"

Reduced Section Machined Preferably By Milling

JOB SHEET #9

E. After finishing coupon, stamp as indicated (Figure 5)

It is customary to use steel letter and number dies to stamp this information on the face side of the test plate

FIGURE 5

XXX - Indicates the welder identification. Can be 1, 2 or 3 digets or letters or combination of the welders initials, such as W'G.D., or 999 or A99 and 99A. The latter system provides for identifying 5148 welders.

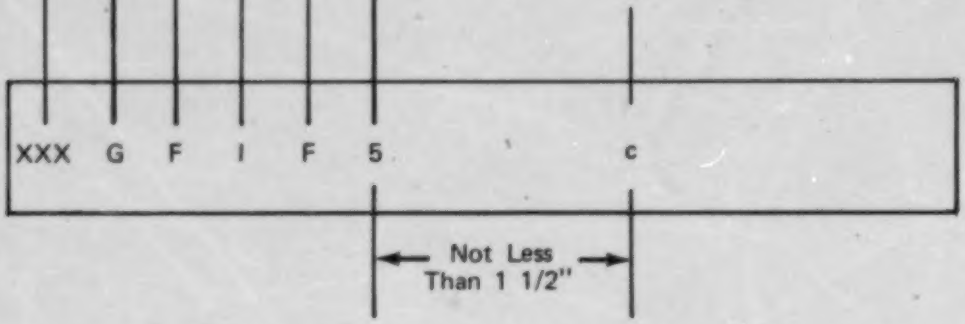
G - Indicates the type of joint. G=Groove, F=Fillet.

F - Indicates the position of the weld test. F=Flat, H=Horizontal, V=Vertical, O=Overhead.

I - Indicates type of electrode with the last diget of the A.W.S. classification. O=E-6010, I=E-6011, 2=E-6012, etc.

F - Indicates the type of test. F=Face Bend, (face of weld on convex side of coupon), R=Root Bend.

5 - Indicates the diameter of the electrode in 32nds, i.e., 4=1/8", 5=5/32", 6=3/16", etc.



METHOD OF MARKING TEST COUPONS

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #10--TEST THE PREPARED COUPON

I. Equipment and materials

   A. Guided bend testing machine--Most common type of weld testing equipment used for root and face bend tests

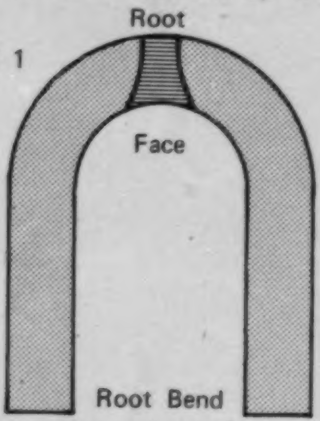
   B. Tensile testing machine--Used for tensile tests

II. Procedure--Place prepared coupon in testing machine as instructed

   A. Do not use testing machine unless instructor is present

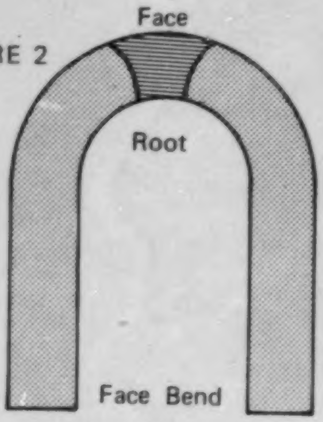
   B. Make a root bend with root side up (Figure 1)

FIGURE 1



   C. Make a face bend with face side up (Figure 2)

FIGURE 2



JOB SHEET #10

D. Make a tensile test

(NOTE: Check with instructor for proper procedures.)

(CAUTION: Extreme care should be taken when setting up specimen to prevent metal from flying out of testing machine.)

E. Standard of acceptability

CONTOUR:	The exposed face of the weld shall be reasonably smooth and regular. There shall be no overlapping or undercutting.
EXTENT OF FUSION:	There shall be complete fusion between the weld and base metal and full penetration to the root of the weld.
SOUNDNESS:	The weld shall contain no gas pocket, oxide particle or slag inclusion exceeding 1/8" in greatest dimension. In addition, no square inch of weld metal area shall contain more than 6 gas pockets exceeding 1/16" in greatest dimension.
REDUCED-SECTION TENSION TEST:	The tensile strength shall not be less than 100% of the minimum of the specified tensile range of the base material used.

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #11--MAKE A SINGLE V-GROOVE BUTT WELD IN FLAT POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

   A. Arc welding station and required tools

   B. Mild steel two pieces 3/8" thick, 5" x 6"

   C. Electrode E-6010 1/8" or 5/32"

      1. 1/8" - 75-130 amps

      2. 5/32" - 90-175 amps

   D. Current DCRP + at the electrode

   E. Protective clothing

II. Procedure

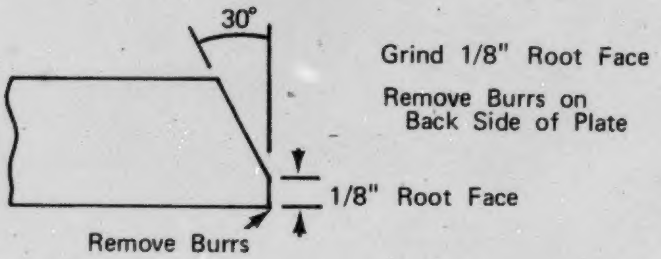
   A. Adjust welding machine for correct current and amperage settings

   B. Prepare metal for welding

      1. Bevel edges of plates 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate

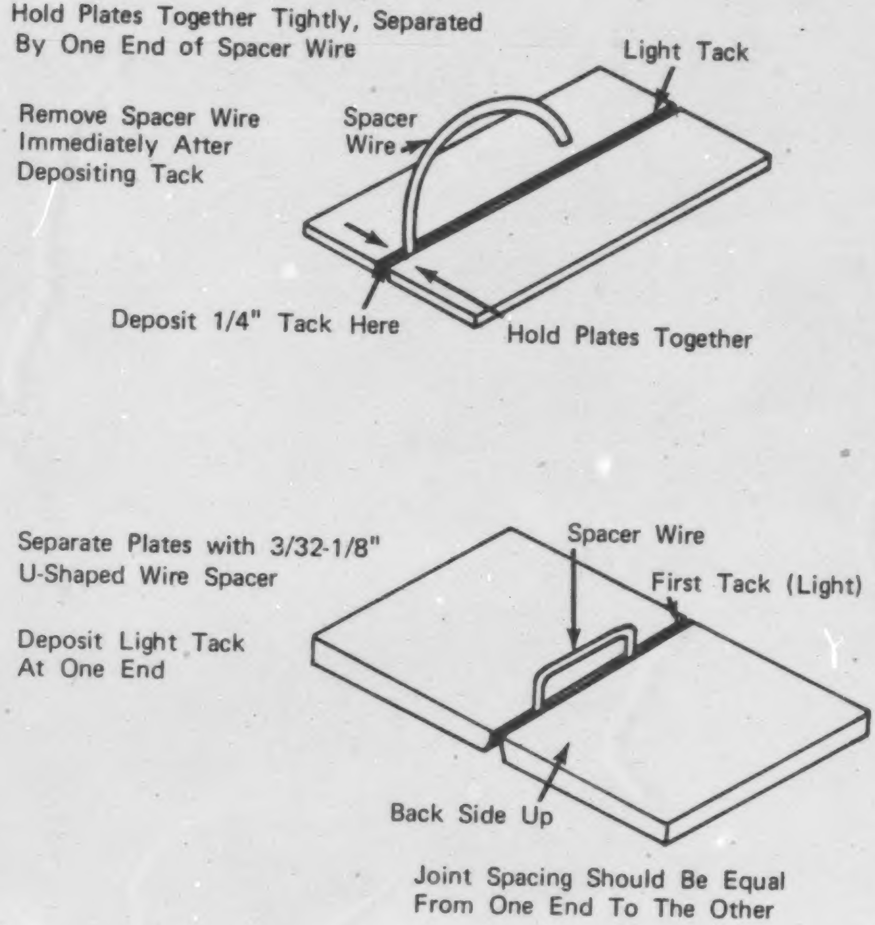

30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

      2. Remove all burrs and slag

JOB SHEET #11

C. Place metal together parallel to each other leaving a root gap from 3/32" to 1/8" in flat position (Figure 2)

FIGURE 2


Hold Plates Together Tightly, Separated By One End of Spacer Wire
Light Tack
Remove Spacer Wire Immediately After Depositing Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Separate Plates with 3/32-1/8" U-Shaped Wire Spacer
Spacer Wire
First Tack (Light)
Deposit Light Tack At One End
Back Side Up
Joint Spacing Should Be Equal From One End To The Other

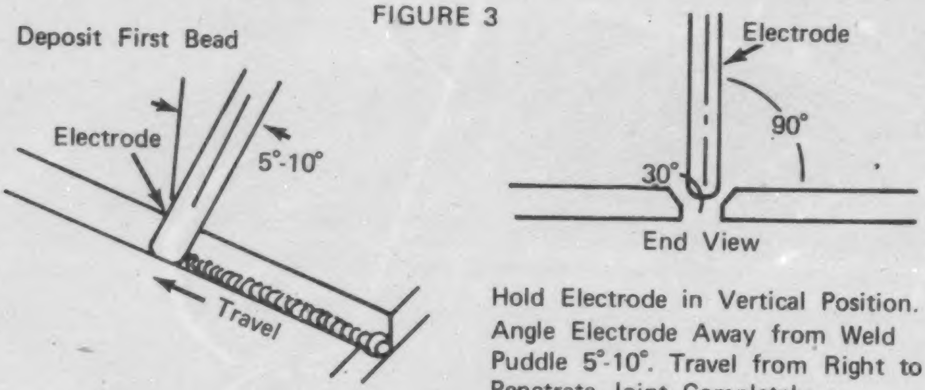
D. Tack pieces together at both ends and feather tack with a right angle grinder

(NOTE: Place a strip of metal under each piece to hold it off table top when welding.)

JOB SHEET #11

E. Position electrode straight into plate and angle 5°-10° away from weld puddle (Figure 3)

FIGURE 3

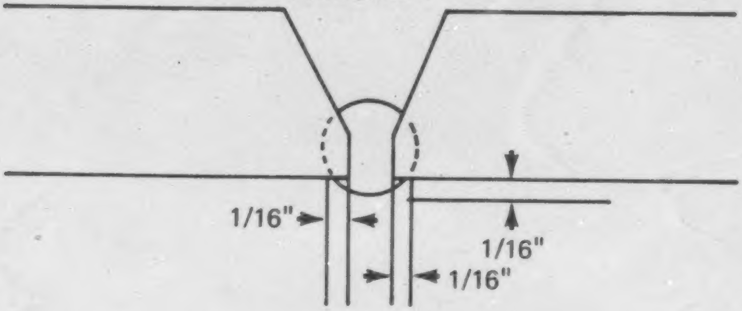

Deposit First Bead
Electrode
5°-10°
Travel
Electrode
90°
30°
End View

Hold Electrode in Vertical Position. Angle Electrode Away from Weld Puddle 5°-10°. Travel from Right to Left. Penetrate Joint Completely.

F. Strike high arc length to heat plates, then move to end and weld plates together using a stringer bead

(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" of an inch on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate.) (Figure 4)

FIGURE 4



(CAUTION: Avoid undercutting faces of groove.)

G. Chip slag and brush weld clean

JOB SHEET #11

H. Deposit necessary filler passes to fill out the V, using care to remove all slag deposits between each pass

(NOTE: Filler passes can be stringers or weaves.)

I. Make cover pass or passes slightly convex overlapping edge of groove 1/16" on each side

J. Cut and prepare two coupons out of this weld

K. Cool plates slowly

(CAUTION: Do not place plates in water.)

L. Turn in plate to instructor for testing

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #12--MAKE A SINGLE V-GROOVE BUTT WELD IN THE HORIZONTAL POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

  A. Arc welding station and required tools

  B. Mild steel plates two pieces 3/8" thick 5" x 6"

  C. Electrode E-6010 1/8" or 5/32"

    1. 1/8" - 75-130 amps

    2. 5/32" - 90-175 amps

  C. Current DCRP + at the electrode

  D. Protective clothing

II. Procedure

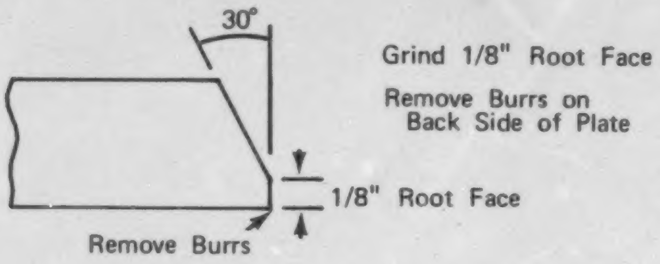
  A. Adjust welding machine for correct current and amperage settings

  B. Prepare plates for welding

    1. Bevel each plate 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate


30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

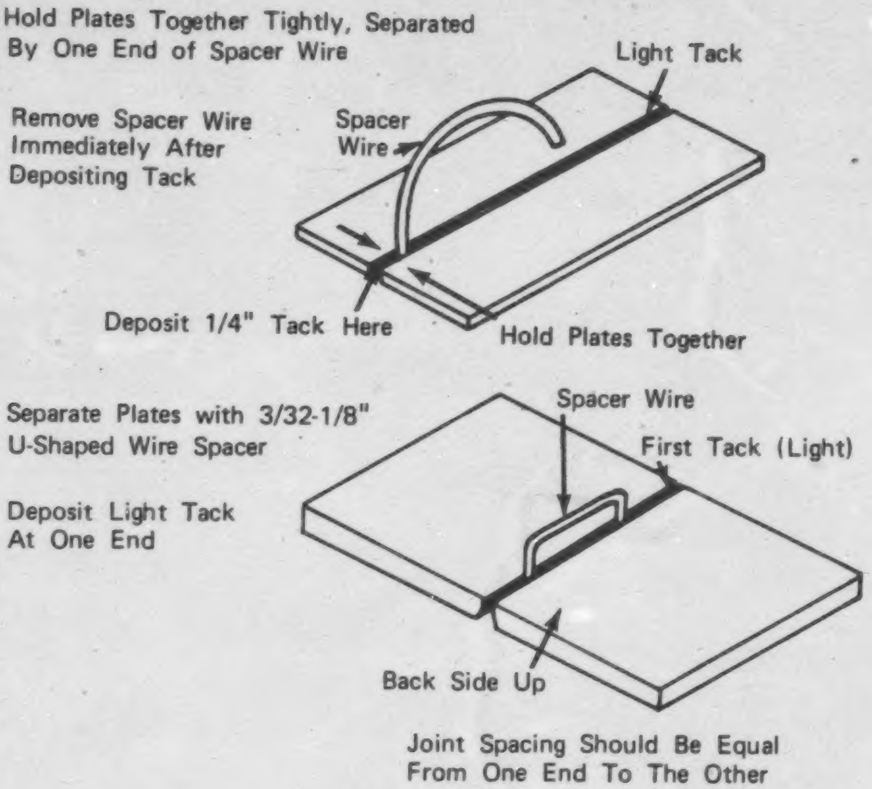
    2. Remove all burrs and slag if flame cut

  C. Tack plates together leaving a root gap of 3/32"-1/8" slag and feather tacks

JOB SHEET #12

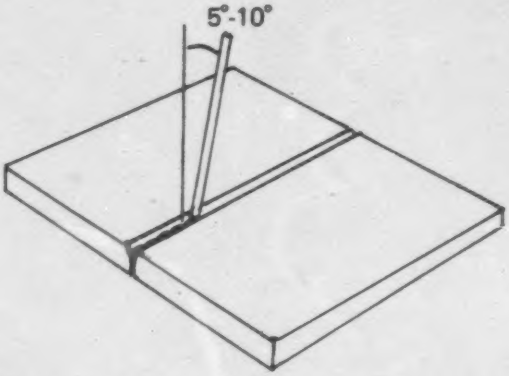
D. Position plates vertically as shown (Figure 2)

FIGURE 2


Hold Plates Together Tightly, Separated By One End of Spacer Wire
Light Tack
Remove Spacer Wire Immediately After Depositing Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Separate Plates with 3/32-1/8" U-Shaped Wire Spacer
Spacer Wire
First Tack (Light)
Deposit Light Tack At One End
Back Side Up
Joint Spacing Should Be Equal From One End To The Other

E. Hold electrode 90° or straight into joint tilting 5°-10° in direction of travel (Figure 3)

FIGURE 3

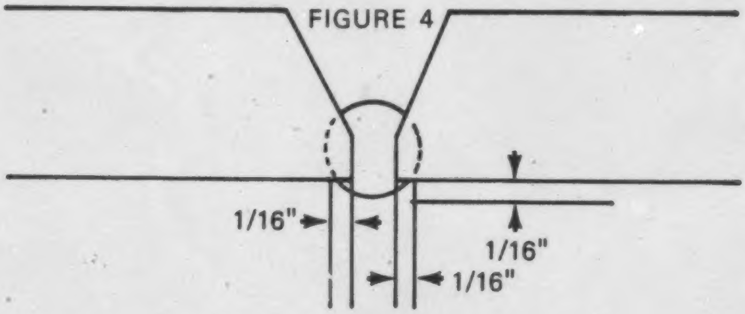


JOB SHEET #12

F. Strike arc and hold high arc length to heat plates and use root pass

(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" of an inch on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate.) (Figure 4)

FIGURE 4



G. Chip slag and brush weld clean after each pass

H. Deposit additional welds as stringers or weaves (as determined by instructor)

I. Make cover pass or passes slightly convex and overlapping top edge of groove 1/16" on each side

J. Cut and prepare coupons

K. Cool plate in still air slowly

(CAUTION: Do not cool in water.)

L. Test coupons

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #13--MAKE A SINGLE V-GROOVE BUTT WELD IN THE VERTICAL UP POSITION AND TEST

I. Equipment and materials

A. Arc welding station and required tools

B. Mild steel plates two pieces 3/8" thick, 5" x 6"

C. Electrode E-6010 1/8" or 5/32"

1. 1/8" electrode 75-130 amps

2. 5/32" electrode 90-175 amps

D. Current DCRP + at the electrode

E. Protective clothing

II. Procedure

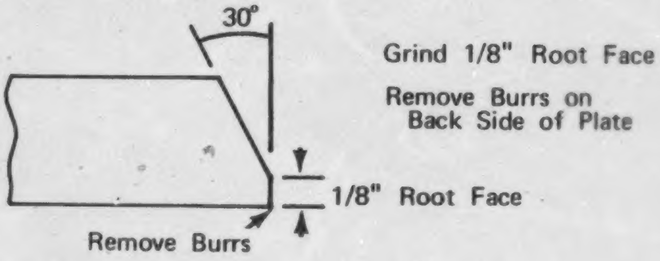
A. Adjust welding machine for correct current and amperage settings

(NOTE: Vertical up requires less amperage than flat and horizontal welding.)

B. Prepare plates for welding (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate


30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

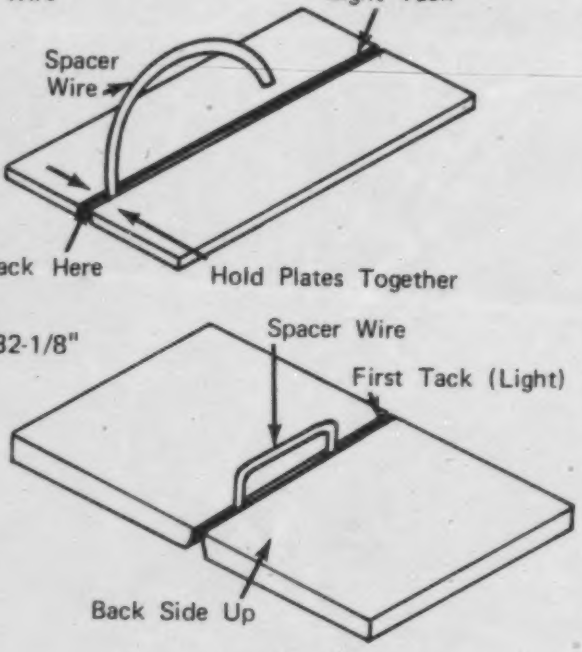
1. Bevel each plate 30°

2. Remove all burrs and slag if flame cut

JOB SHEET #13

3. Tack plates together leaving a 3/32" to 1/8" root gap (Figure 2)

FIGURE 2


Hold Plates Together Tightly, Separated By One End of Spacer Wire
Light Tack
Remove Spacer Wire Immediately After Depositing Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Separate Plates with 3/32-1/8" U-Shaped Wire Spacer
Spacer Wire
First Tack (Light)
Deposit Light Tack At One End
Back Side Up
Joint Spacing Should Be Equal From One End To The Other

4. Slag and feather tacks as necessary

C. Position plates in vertical position (Figure 3)

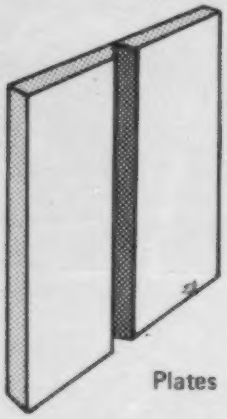


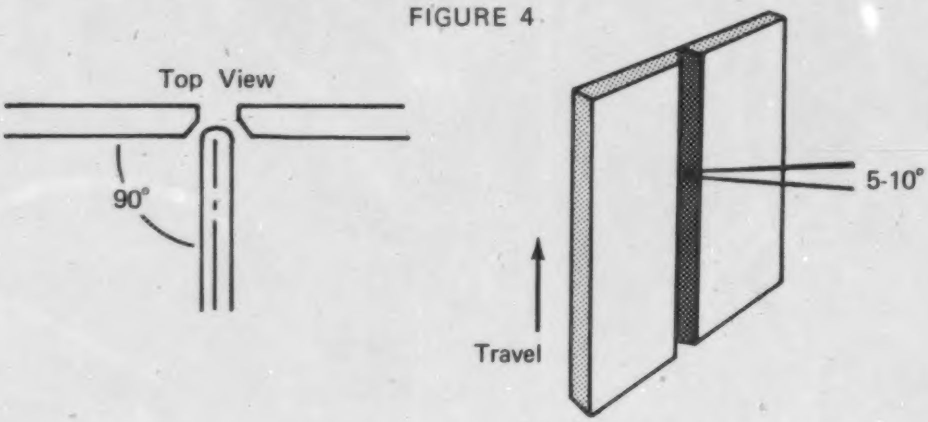
FIGURE 3

Plates Vertical Axis of Weld Vertical

JOB SHEET #13

D. Position electrode 90° or straight into joint angling electrode 5°-10° up from horizontal (Figure 4)

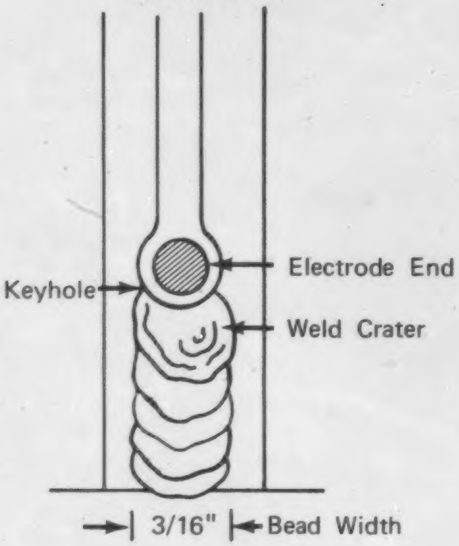
FIGURE 4


Top View
90°
5-10°
Travel

E. Strike arc and hold a high arc length to heat plates; move to bottom of plate and start weld

(NOTE: Melt out key hole as large as electrode diameter as illustrated in Figure 5.)

FIGURE 5


Electrode End
Keyhole
Weld Crater
3/16"
Bead Width

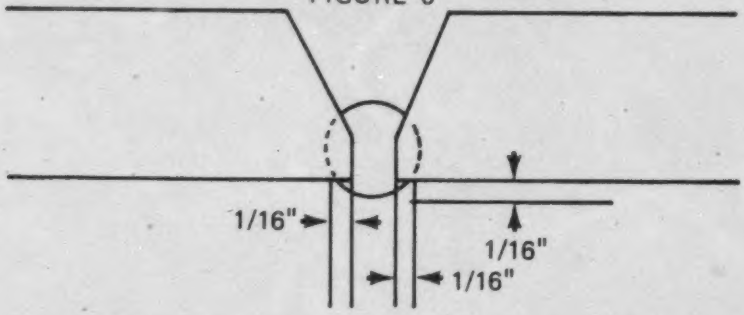
JOB SHEET #13

F. Fill crater to about 3/16" bead width

(NOTE: Some form of electrode manipulation is helpful in forming a bead.) (Figure 6)

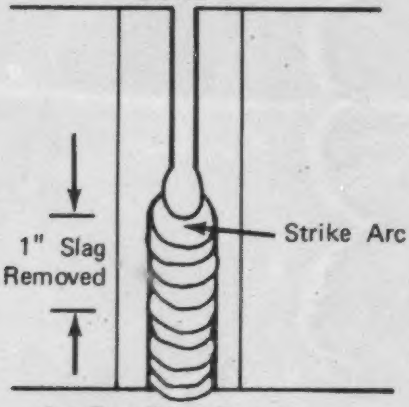
(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" of an inch on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate.) (See Figure 6.)

FIGURE 6



G. Should arc be broken before completion of bead, remove slag from end of bead and restrike arc below keyhole (Figure 7)

FIGURE 7



Arc-Restriking Procedure

H. Remove slag and brush each weld before applying next pass

I. Deposit necessary filler passes to fill joint using stringers or weaves

J. Make cover pass or passes slightly convex and overlapping top edge of groove 1/16" on each side

JOB SHEET #13

K. Cut and prepare coupons

L. Cool plates or coupons in still air slowly

(CAUTION: Do not cool in water.)

M. Test coupons

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

JOB SHEET #14--MAKE A SINGLE V-GROOVE BUTT WELD IN THE OVERHEAD POSITION AND TEST

(NOTE: This welding exercise will be tested.)

I. Equipment and materials

   A. Arc welding station with necessary tools and equipment

   B. Two mild steel plates 3/8" x 5" x 6"

   C. Electrode E6010 1/8" or 5/32"

      1. 1/8" electrode - 75-130 amps

      2. 5/32" electrode - 90-175 amps

   D. Current DCRP + at the electrode

   E. Protective clothing

II. Procedure

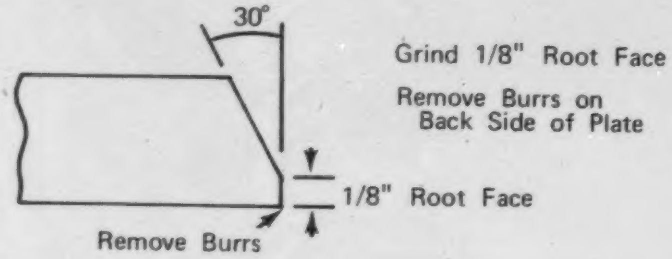
   A. Adjust welding machine for correct current and amperage settings

   B. Prepare plates for welding

      1. Bevel one long side of each plate 30° (Figure 1)

FIGURE 1

Bevel One Long Side of Each Plate

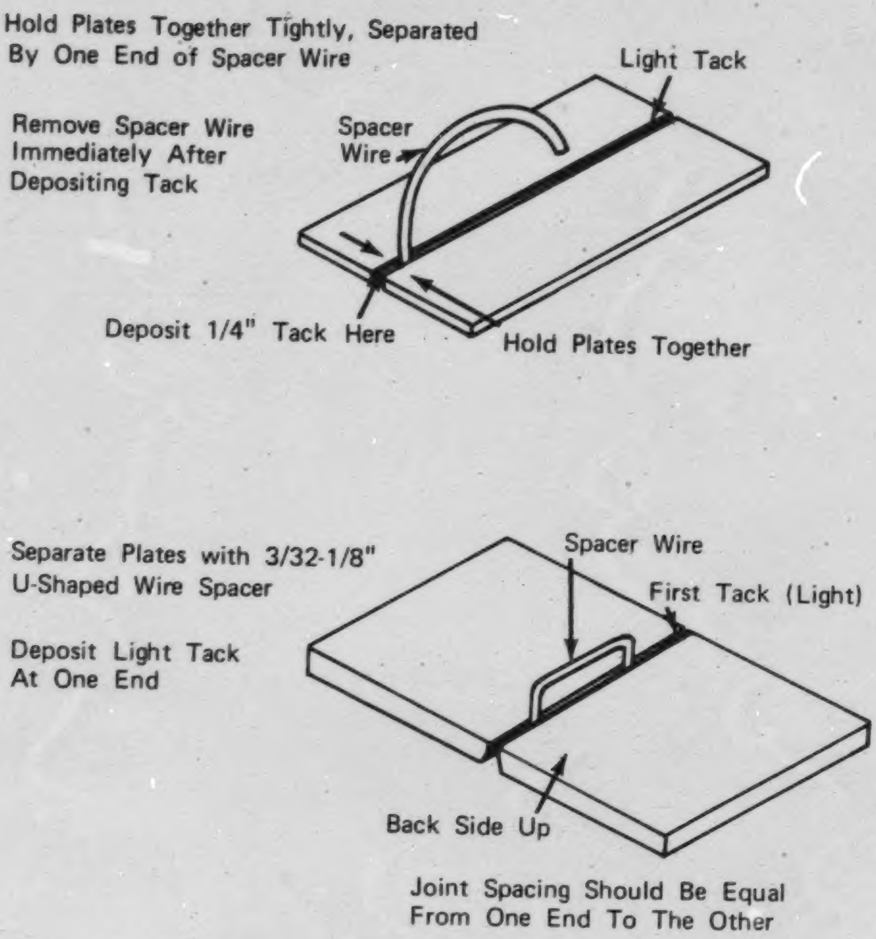

30°
Grind 1/8" Root Face
Remove Burrs on Back Side of Plate
1/8" Root Face
Remove Burrs

      2. Remove all burrs and slag

JOB SHEET #14

3. Tack plates together with a 3/32"-1/8" root gap (Figure 2)

FIGURE 2



Hold Plates Together Tightly, Separated By One End of Spacer Wire

Remove Spacer Wire Immediately After Depositing Tack

Separate Plates with 3/32-1/8" U-Shaped Wire Spacer

Deposit Light Tack At One End

Joint Spacing Should Be Equal From One End To The Other

Light Tack
Spacer Wire
Deposit 1/4" Tack Here
Hold Plates Together
Spacer Wire
First Tack (Light)
Back Side Up

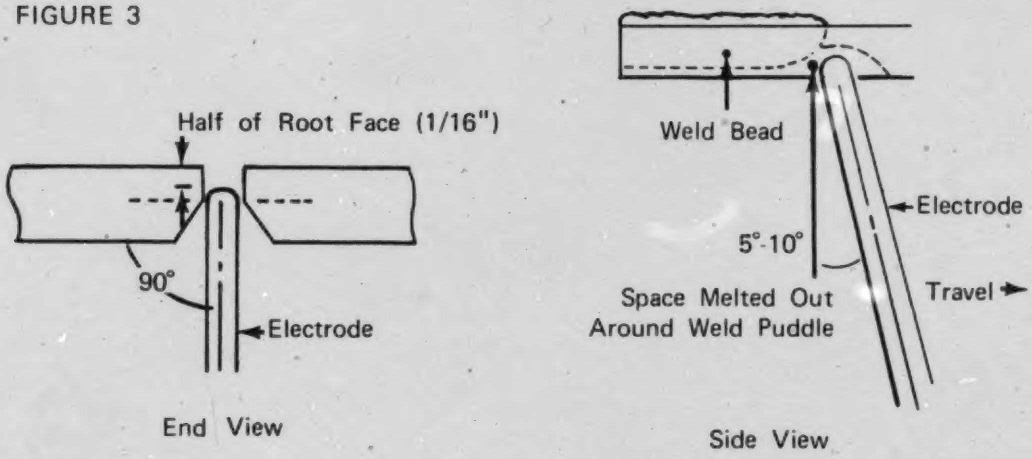
4. Slag and feather tacks if necessary

C. Position plates in overhead position

JOB SHEET #14

D. Hold electrode straight into joint vertically and angled 5°-10° in direction of travel (Figure 3)

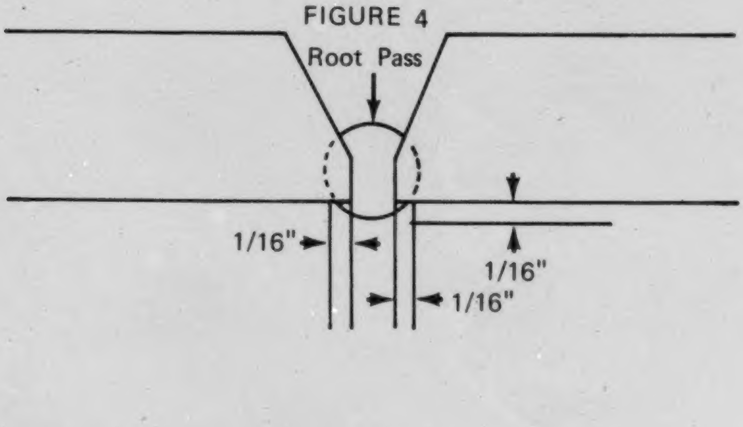
FIGURE 3


Half of Root Face (1/16")
90°
Electrode
End View
Weld Bead
Electrode
5°-10°
Travel
Space Melted Out Around Weld Puddle
Side View

E. Strike arc holding long arc to heat plates and prevent cold lap; move to end of plate and start weld

(NOTE: The root pass should have 100% penetration on both plates extending through the root and overlapping 1/16" of an inch on each side. Also, the back of the root pass should have a convex appearance when observed from the bottom of the plate.) (Figure 4)

FIGURE 4

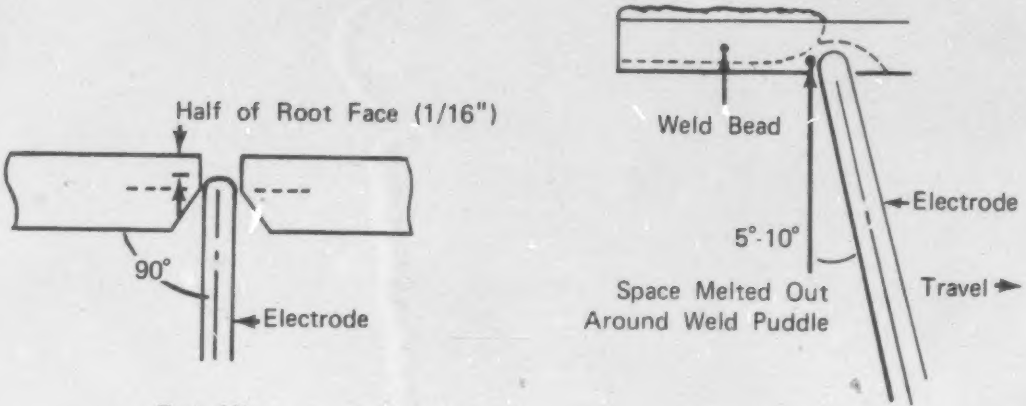

Root Pass
1/16"
1/16"
1/16"

JOB SHEET #14

F. As root pass is run, welding technique should be as follows

1. Hold short arc length and position end of electrode half-way into root gap (Figure 5)

FIGURE 5

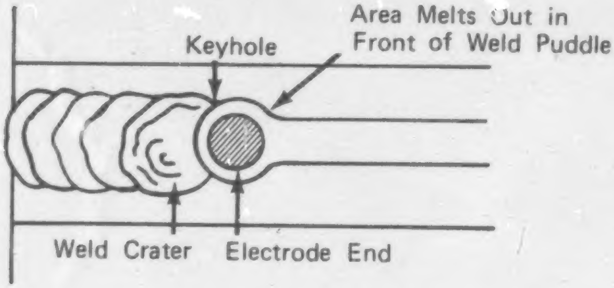

Half of Root Face (1/16")
90°
Electrode
Weld Bead
Electrode
5°-10°
Space Melted Out Around Weld Puddle
Travel

End View

Side View

2. A keyhole should form in front of weld puddle to insure good fusion to root of joint (Figure 6)

FIGURE 6

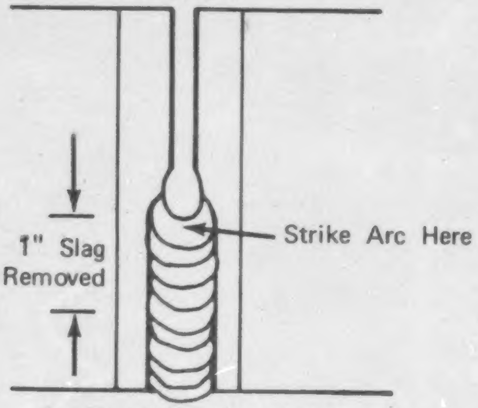

Keyhole
Area Melts Out in Front of Weld Puddle
Weld Crater
Electrode End

3. Deposit thin layers of filler metal using some form of rod manipulation to control weld puddle

JOB SHEET #14

G. Should arc be broken before weld is completed, remove slag from one inch of bead and restrike arc (Figure 7)

FIGURE 7

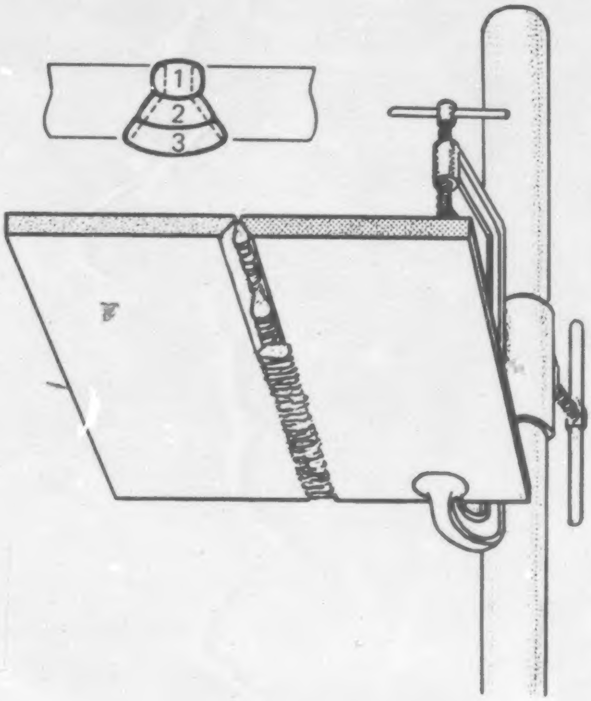

1" Slag Removed
Strike Arc Here

Arc-Restriking Procedure

H. Slag each pass thoroughly before applying next one

I. Deposit filler passes to fill joint using stringers or weaves (Figure 8)

FIGURE 8



JOB SHEET #14

J. Cover pass or passes should be well fused into previous passes with a 1/16" overlap at the top and on both sides of V-joint; bead should be convex in contour

K. Cut and prepare coupons

L. Cool plates in still air, never water

M. Test coupons

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

TEST

1. Match the following terms with their definitions.

______a. The portion of the crater left unfilled due to excessive current and the improper movement of the electrode occuring at the edge of the bead

______b. That portion of a weld which is removed from the test plate to test for strength

______c. The exposed surface of a fusion weld

______d. The distance from the original surface of the base metal to that point at which fusion ceases

______e. A series of overlapping stringer beads that completely cover the surface of a practice plate increasing its thickness by each subsequent layer

______f. The running of a horizontal bead on a vertical surface

______g. A concentration of magnetic force acting on the welding arc causing it to deflect, move, or "blow" from its normal path

______h. The bottom surface of a weld on the opposite side from which welding was done

______i. A piling up of weld metal due to improper starts and current adjustments causing a defect usually at the start of the weld

1. Root
2. Pad
3. Undercutting
4. Arc blow
5. Penetration
6. Vertical position
7. Porosity
8. Root opening
9. Fusion
10. String bead
11. Horizontal position
12. Weld face
13. Cold lap
14. Slag inclusion
15. Coupon
16. Crater
17. Overhead position

_____j. Non-metallic porous material entrapped in weld metal or between the weld metal and base metal

_____k. The beads are deposited in a vertical position on a vertical surface; axis of weld is vertical.

_____l. A weld bead made with very little rod manipulation

_____m. A condition caused by a trapped gas pocket in a gas pocket in a weld as it solidifies

_____n. The melting of metals until the molten portions unite with each other

_____o. The gap between members to be joined at the root of the joint

_____p. A depression in the face of a weld caused by arc force; usually found at the end of a bead

_____q. The position of welding wherein welding is performed from the underside of the joint

2. Name four factors that determine proper machine adjustment.

a.

b.

c.

d.

3. Name the four welding positions.

a.

b.

c.

d.

4. Place an "X" by the side of each word indicating reasons for removing slag from a weld.

_____a. Prevents better fusion of beads

_____b. Prevents penetration

_____c. Prevents gas pockets and slag inclusions from forming in bead

_____d. Improves appearance of bead

_____e. Causes irregular arc

5. Name three reasons for fusing one bead in with another.

a.

b.

c.

6. Name four factors that determine weld quality.

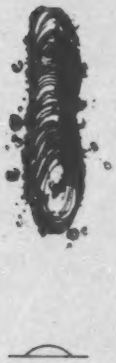
a.

b.

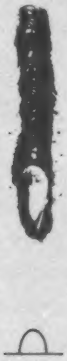
c.

d.

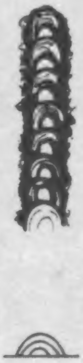
7. Identify the following examples of properly and improperly formed beads by telling what caused each one.



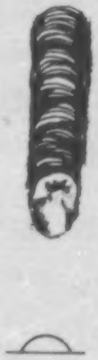
a. ____________



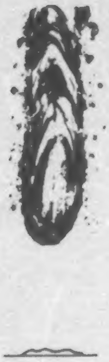
b. ____________



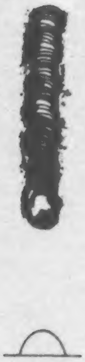
c. ____________



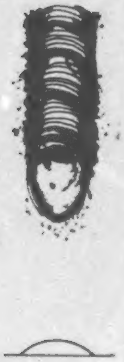
d. ____________



e. ____________



f. ____________



g. ____________

8. Name two causes and two solutions to prevent arc blow.

a. Causes

1)

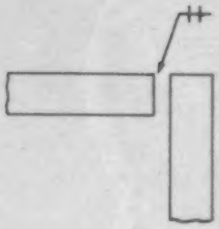
2)

b. Solutions

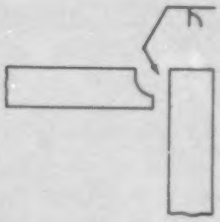
1)

2)

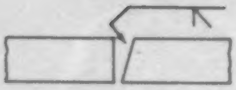
9. Identify the different types of groove joints.



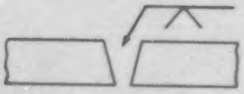
a. ____________



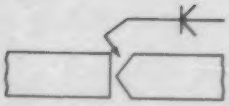
b. ____________



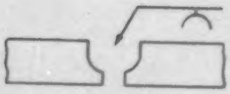
c. ____________



d. ____________



e. ____________



f. ____________

10. Demonstrate the ability to:

a. Build a pad in the horizontal position.

b. Construct a multiple pass T-joint in the horizontal position.

c. Weld a square groove butt weld in the horizontal position.

d. Build a pad in the vertical up position.

e. Make a T-joint in the vertical up position.

f. Make a square groove butt joint in the vertical down position.

g. Build a pad in the overhead position.

h. Make a lap joint in the overhead position.

i. Lay out, cut, and prepare weld coupons for testing.

j. Test weld coupons.

k. Make a single V-groove joint in the flat position and test.

l. Make a single V-groove joint in the horizontal position and test.

m. Make a single V-groove joint in the vertical up position and test.

n. Make a single V-groove joint in the overhead position and test.

(NOTE: This is not a test question. Check with instructor if you have not completed the welding jobs.)

SHIELDED METAL ARC WELDING
POSITION WELDING
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 15
   c. 12
   d. 5
   e. 2
   f. 11
   g. 4
   h. 1
   i. 13
   j. 14
   k. 6
   l. 10
   m. 7
   n. 9
   o. 8
   p. 16
   q. 17

2. Any four of the following:
   a. Thickness of base metal
   b. Diameter and type of electrode
   c. Welding position
   d. Welding technique used by operator
   e. Length of welding cables
   f. Efficiency of welding machine and polarity

3. a. Flat
   b. Vertical
   c. Horizontal
   d. Overhead
4. c
   d
5. a. Increases strength of weld
   b. Improves appearance of bead
   c. Improves penetration
6. a. Amperage
   b. Length of arc
   c. Speed of travel
   d. Position of electrode
7. a. Current high
   b. Current low
   c. Speed fast
   d. Current, voltage, and speed normal
   e. Voltage high
   f. Voltage low
   g. Speed slow
8. a. Causes
      1) Magnetic forces present with DC current build up lines of magnetism around the arc causing it to be unstable with excessive spatter
      2) High amperage, thick plates, corners, deep grooves, and the start and finish of joints are the major problem areas

   Any two of the following:

   b. Solutions
      1) Reduce current or switch polarity
      2) Change current to AC

3) Change location of ground clamp

4) Wrap ground cable around work piece and pass ground current through it to neutralize magnetic field

5) Maintain a short arc

9. a. Square

b. J-groove

c. Single bevel

d. Single V

e. Double bevel

f. U-groove

10. Practice exercises perfomed from the job sheets will be evaluated to the satisfaction of the instructor.

GAS TUNGSTEN ARC WELDING
UNIT I

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms of the GTAW process with their definitions. He should be able to identify the applications and advantages of the process. He should be able to identify all major parts of the equipment and the function of each. He should be familar with the appropriate filler metals and the metallurgical properties of the base metals to be welded. He should be able to demonstrate the ability to set up the equipment and produce welds on the popular metals in the flat through vertical positions on the common joints. This knowledge will be evidenced by scoring eighty-five percent on a unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the GTAW process with the correct definition.
2. Name three applications of the GTAW process.
3. Select five advantages of the GTAW welding process.
4. Identify the major controls of the GTAW power supply.
5. Name the two types of welding current used most in GTAW process.
6. Identify the six major parts of a GTAW torch.
7. Name three of the most commonly used gas cups for GTAW welding.
8. Name the color, finish, type, and application when given the type of tungsten electrode.
9. Match the correct filler metal to the base metal being welded.
10. List the major metallurgical factors to be considered when welding aluminum and stainless steel.
11. Match given illustrations of poor welds with the cause of each.
12. Name five characteristics of a good weld.
13. List the characteristics of argon and helium shielding gases used in GTAW process.

14. Demonstrate the ability to:

    a. Set up the GTAW power supply, select and adjust the correct current for aluminum, and shut down the equipment.

    b. Set up the GTAW power supply, select and adjust the correct current for stainless and mild steel, and shut down equipment.

    c. Clean aluminum, stainless, and mild steel both mechanically and chemically.

    d. Run stringer beads on one-sixteenth inch aluminum in the flat position with filler rod.

    e. Construct a square groove butt weld on one-eighth inch aluminum in the flat position with filler rod.

    f. Construct a lap joint fillet weld on one-eighth inch aluminum in the horizontal position with filler rod.

    g. Construct an outside corner fillet weld joint on one-eighth inch aluminum in the flat position without filler rod.

    h. Construct a T-joint fillet weld on one-eighth inch aluminum in the horizontal position with filler rod.

    i. Construct a T-joint fillet weld on one-eighth inch aluminum in the vertical up position with filler rod.

    j. Construct a butt joint on one-sixteenth inch mild steel in the flat position with filler rod.

    k. Construct a lap joint fillet weld on one-sixteenth inch mild steel in the horizontal position with filler rod.

    l. Construct a T-joint fillet weld on one-sixteenth inch mild steel in the horizontal position with filler rod.

    m. Construct a butt joint on one-sixteenth inch stainless steel in the flat position with filler rod.

    n. Construct an outside corner joint fillet weld on one-sixteenth inch stainless steel in the flat position without filler rod.

    o. Construct a T-joint fillet weld on one-eighth inch stainless steel in the horizontal position with filler rod.

    p. Construct a T-joint fillet weld on one-eighth inch stainless steel in the vertical up position with filler rod.

GAS TUNGSTEN ARC WELDING
UNIT I

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide students with objective sheet.

  B. Provide students with information, assignment, and job sheets.

  C. Discuss terminal and specific objectives.

  D. Discuss information and assignment sheets.

  E. Demonstrate and discuss procedures outlined in job sheets.

  F. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Complete assignment sheets.

  D. Demonstrate the ability to accomplish the procedures outlined in the job sheet.

  E. Take test.

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparencies

    1. TM 1--GTAW Equipment

    2. TM 2--GTAW Process

    3. TM 3--GTAW Power Supply

    4. TM 4--GTAW Torch

5. TM 5a and 5b--GTAW Electrodes
6. TM 6--Causes of Poor Welds
7. TM 7--Example of a Good Weld

D. Assignment sheets

1. Assignment Sheet #1--Aluminum Filler Metals
2. Assignment Sheet #2--Stainless Steel Filler Metals

E. Job sheets

1. Job Sheet #1--Set Up and Shut Down Power Supply for Welding Aluminum
2. Job Sheet #2--Set Up and Shut Down Power Supply for Welding Mild and Stainless Steel
3. Job Sheet #3--Metal Preparation of Aluminum, Stainless, and Mild Steel Before Welding
4. Job Sheet #4--Make Stringer Beads on One-Sixteenth Inch Aluminum with Filler Rod in the Flat Position
5. Job Sheet #5--Construct a Square Groove Butt Weld on One-Eighth Inch Aluminum in the Flat Position
6. Job Sheet #6--Make a Lap Joint Fillet Weld on One-Eighth Inch Aluminum With Filler Rod in the Horizontal Position
7. Job Sheet #7--Construct a Corner Joint Fillet Weld on One-Eighth Inch Aluminum Without Filler Rod in the Flat Position
8. Job Sheet #8--Weld a T-Joint Fillet Weld on One-Eighth Inch Aluminum With Filler Rod in the Horizontal Position
9. Job Sheet #9--Construct a T-Joint Fillet Weld on One-Eighth Inch Aluminum With Filler Rod in the Vertical Up Position
10. Job Sheet #10--Construct a Butt Joint on One-Sixteenth Inch (16 ga) Mild Steel With Filler Rod in the Flat Position
11. Job Sheet #11--Construct a Lap Joint Fillet Weld on One-Sixteenth Inch Mild Steel With Filler Rod in the Horizontal Position
12. Job Sheet #12--Construct a T-Joint Fillet Weld on One-Sixteenth Inch Mild Steel With Filler Rod in the Horizontal Position

    13. Job Sheet #13--Construct a Butt Joint on One-Sixteenth Inch Stainless Steel With Filler Rod in the Flat Position

    14. Job Sheet #14--Construct an Outside Corner Joint on One-Sixteenth Inch Stainless Steel Without Filler Rod in the Flat Position

    15. Job Sheet #15--Construct a T-Joint Fillet Weld on One-Eighth Inch Stainless Steel With Filler Rod in the Horizontal Position

    16. Job Sheet #16--Construct a T-Joint Fillet Weld on One-Eighth Inch Stainless Steel With Filler Rod in the Vertical Up Position

E. Test

F. Answers to test

II. References:

A. Griffin, Ivan H. and Edward M. Roden. *Basic TIG and MIG Welding.* New York: Delmar Publishing Company.

B. Sullivan, R. P. *Fundamentals and Theory of Tungsten Inert Gas Arc Welding.* Newark, New Jersey: Linde Division Union Carbide.

C. Birdsall, G. W. *Fusion Welding Aluminum.* Richmond, Virginia: Reynolds Metals Company.

D. *Hobart Welding Guide and Lessons.* Troy, Ohio: Hobart School of Welding Technology.

E. *Hobart Welding School Workbook.* Troy, Ohio: Hobart School of Welding Technology.

F. *Jefferson, T. B. and Gorham Woods. Metals and How to Weld Them.* Cleveland, Ohio: James F. Lincoln Foundation.

G. *Stainless Steel: What It Is and How to Weld It.* Whittier, California: Stoody Company.

H. *The Welding Encyclopedia.* Morton Grove, Illinois: The Welding Engineer Publishing Company Monticello Books.

I. *Welding Alcoa Aluminum.* Pittsburg, Pennsylvania: Aluminum Company of America.

J. *Welding Handbook.* Sixth Edition. Miami, Florida: American Welding Society.

K. *Welding Kaiser Aluminum.* Oakland, California: Kaiser Aluminum and Chemical Sales Inc.

GAS TUNGSTEN ARC WELDING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Gas Tungsten Arc Welding (GTAW) (Transparencies 1 and 2)--An arc welding process wherein coalescence (fusion) is produced by heating with an arc between a non-consumable tungsten electrode and the base metal utilizing an inert gas, argon, or helium that shields the weld zone from contamination by oxygen and nitrogen in the air

(NOTE: TIG is a common term used to describe this process.)

B. Inert shielding gas--A gas, which will not combine with other gases used to surround the weld zone and prevent contamination of the weld by oxygen and nitrogen in the air

C. Tungsten electrode--A practically non-consumable welding electrode used to create an intense arc between the tip of the electrode and the work

D. High frequency current--A high voltage low power source introduced into the A. C. weld current to start the arc and aid in oxide removal when welding aluminum

E. Flowmeter--A calibrated metering device used to regulate the flow of gases to the torch and measured in cubic feet per hour (c. f. h.)

F. Collet--A chucking device used to hold the tungsten in the torch

G. Collet body or (chuck)--A holding device for the collet

H. Foot control--A device used by the welder to control welding current during the welding process

I. Gas cup--An attachment that fits on the end of the GTAW torch to direct the flow of shielding gas to the tungsten and weld zone

J. Porosity--Gas pockets or voids in metal

K. Thermal conductivity-The characteristic of a metal to conduct heat throughout its thickness, width, and length

L. Metallurgy--The science and technology of metals

M. Aluminum oxide--A thin film that forms on the surface of aluminum due to a reaction between the metal and oxygen in the air

INFORMATION SHEET

II. Applications of GTAW

  A. Makes top quality welds possible on most all metals and alloys used in industry

  B. Welds possible in all positions through a wide range of metal thickness

  C. Used particularly for aluminum and its alloys (even on very thin sections)

III. Advantages of GTAW

  A. No flux used and no post cleaning required

  B. Arc and weld puddle clearly visible to welder

  C. No slag or spatter

  D. Makes excellent root pass on carbon and stainless steel pipe

  E. Minimum of distortion and stress with heat concentrated in a small area

  F. Welder has very close control of welding current

IV. GTAW power supply controls (Transparency 3)

  A. Weld control switch--SMAW or GTAW welding

  B. Current range selector

  C. Fine adjustment current control

  D. Polarity switch--current type

    1. AC

    2. DCSP

    3. DCRP

  E. High frequency

    1. Start only position

    2. Continuous position

    3. Off position

    4. Intensity rheostat

  F. Gas and water connections in and out with solenoid valves

INFORMATION SHEET

G. Terminals

  1. Ground

  2. Electrode

H. Remote control

  1. Receptacles--Foot control

  2. Control switch

    a. Remote

    b. Manual

I. Shielding gas afterflow timer (post purge 0-60 seconds)

J. Soft start--Reduces current during starting

V. GTAW current

A. Alternating current (AC) with high frequency for aluminum and magnesium

B. Direct current straight polarity (DCSP) for mild and stainless steel

VI. Major parts of the GTAW torch (Transparency 4)

A. Cap--Holds and tightens tungsten electrode in collet

B. Electrode--Tungsten

C. Collet--Holds tungsten electrode

D. Collet holder (body)--Holds collet with threads for holding gas cup (nozzle)

E. Gas cup--Nozzle directs the flow of shielding gas around the tungsten to the weld zone preventing contamination of the electrode and the weld

VII. Types of cups (nozzles)

A. Ceramic--Least expensive and most popular

B. Pyrex glass--See through

C. Metal--Usually copper

(NOTE: Ceramic and glass nozzles are expensive and easily broken-Handle with care.)

INFORMATION SHEET

VIII. Tungsten electrodes (Transparencies 5a and 5b)

Type of Electrode	Color	Finish	Sizes	Application
Pure	Green	Ground or Chemically Etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Aluminum and Magnesium
1% Thoriated	Yellow	" "	" "	Mild or Stainless Steel
*2% Thoriated	Red	" "	" "	" "
Zirconiated	Brown	" "	" "	X-Ray Quality for Aluminum or Magnesium

* Most common electrode for mild and stainless steel

(NOTE: Tungsten electrodes have a high melting point (6900°F) and are practically nonconsumable. The electrode should never toucn the molten weld puddle. Electrodes contaminated by contact with weld puddle must be reground or they produce a sputtering arc and weld contamination.)

INFORMATION SHEET

IX. GTAW filler metals

A. Aluminum

GUIDE TO THE CHOICE OF FILLER METAL

FOR GTAW WELDING ALUMINUM

		M	L	K	J	I	H	G	F	E	D	C	B	A
	Base metal	Casting alloys												
		43, 355, 356	214,A214 B214,F214	6061, 6062 6063, 6151	5456	5454	5154, 5254(1)	5086, 5356	5083	5052, 5652(1)	5005, 5050	3004, CLAD 3004	1100, 3003, CLAD 3003	1060
A	1060	ER4043	ER4043	ER4043	ER5356 (3),(5)	ER4043	ER4043	ER5356 (3),(5)	ER5356 (3),(5)	ER4043	ER1100 (3)	ER4043	ER1100 (3)	ER1260
B	1100,3003 CLAD 3003	ER4043	ER4043 (5)	ER4043 (5)	ER5356 (3),(5)	ER4043 (5)	ER4043 (5)	ER5356 (3),(5)	ER5356 (3),(5)	ER4043 (5)	ER4043 (5)	ER4043 (5)	ER1100 (3)	
C	3004, CLAD 3004	ER4043	ER4043 (5)	ER4043 (2)	ER5356 (5)	ER5356 (3),(5)	ER5356 (5)	ER5356 (5)	ER5356 (5)	ER5356 (3),(5)	ER4043 (5)	ER4043 (4),(5)		
D	5005, 5050	ER4043	ER4043 (5)	ER4043 (2)	ER5356 (5)	ER4043 (5)	ER5356 (3),(5)	ER5356 (5)	ER5356 (5)	ER4043 (5)	ER4043 (4),(5)			
E	5052, 5652(1)	ER4043 (5)	ER4043 (2)	ER4043 (2)	ER5356 (5)	ER5356 (2),(3)	ER5356 (2)	ER5356 (5)	ER5356 (5)	ER5652 (2),(3)				
F	5083	ER5356 (3),(5)	ER5356 (5)	ER5356 (5)	ER5183 (5),(6)	ER5356 (5)	ER5356 (5)	ER5356 (5)	ER5183 (5),(6)					
G	5086, 5356	ER5356 (3),(5)	ER5356 (5)	ER5356 (5)	ER5356 (5)	ER5356 (5)	ER5356 (5)	ER5356 (5)						
H	5154, 5254(1)	ER5356 (3),(5)	ER5356 (2)	ER5356 (2),(3)	ER5356 (5)	ER5356 (2)	ER5254 (2)							
I	5454	ER5356 (3),(5)	ER5356 (2)	ER5356 (2),(3)	ER5356 (5)	ER5554 (5)								
J	5456	ER5356 (3),(5)	ER5356 (5)	ER5356 (5)	ER5556 (5),(6)									
K	6061,6062, 6063,6151	ER4043 (5)	ER5356 (2),(3)	ER5356 (2),(3)										
L	214,A214 B214,F214	ER4043 (5)	ER5356 (2)											
M	43,355, 356	ER4043 (4)												

(1) Base metal alloys 5652 and 5254 are used for hydrogen peroxide service. ER5254 filler metal is used for welding both alloys for low temperature service (150 F and below.) ER5652 filler metal is used for welding 5652 for high temperature service (150 F and above).

(2) ER5154, ER5254, ER5183, ER5356, ER5554, and ER5556 may be used. In some cases, they provide: 1--improved color match after anodizing treatment, 2--highest weld ductility, and 3--higher weld strength. ER5554 is suitable for elevated temperature service.

(3) ER4043 may be used for some applications.

(4) Filler metal with the same analysis as the base metal is sometimes used.

(5) ER5356, ER5183 or ER5556 may be used.

(6) ER5356 is the third choice.

Courtesy of Hobart Brothers Technical Center, Troy, Ohio.

(NOTE: The composition of the filler metal should be matched to that of the base metal. The size of the filler metal rod is determined by the thickness of base metal and welding current.)

INFORMATION SHEET

B. Stainless

STAINLESS STEEL FILLER METAL GUIDE
for GTAW and GMAW Welding

	Typical Wire Composition (1)						
AISI TYPE	C	Mn	Si	Cr	Ni	Others	APPLICATIONS
308L	.025	1.8	.40	20.6	9.7	- - -	For welding types 304, 308, 321 & 347
308L Hi Sil	.025	1.8	.85	20.6	9.7	- - -	For welding types 301, 304, particularly piping.
309L	.025	1.8	.40	24.0	13.5	- - -	For welding 309 and straight chromium grades when heat treatment is not possible.
310	.12	1.8	.45	26.0	21.0	- - -	For welding 310, 304 clad and stainless overlay.
316L	.025	1.80	.35	19.5	13.0	2.3 Mo	For welding type 316L.
316L Hi Sil	.025	1.80	.85	19.5	13.0	2.3 Mo	For Welding type 316, particularly piping.
317L	.025	1.8	.40	19.0	12.5	3.3 Mo	For welding type 317.
347	.06	1.3	.40	19.5	9.5	.90 Cb	For welding types 321 and 347 where max. corrosion resistance is required.

Note 1 - Remainder is iron.

Note 2 - Hi Sil means "Higher than normal silicon" (Approx. double)
L means "low carbon" (0.03 Max. Carbon)

Note 3 - Clad means that the metal is overlayed with stainless.

Courtesy of Hobart Brothers Technical Center, Troy, Ohio.

INFORMATION SHEET

X. Welding metallurgy

  A. Aluminum

    1. Melting point--Aluminum melts at 1220°F but requires higher welding currents than other metals due to its high thermal conductivity

    (NOTE: Aluminum dissipates heat away from the weld zone five times faster than steel. This requires a high heat input (amperage) to obtain a puddle. It also means the weld puddle solidifies (sets up) faster and makes out-of-position welding easier.)

    2. Aluminum oxide--Forms on the surface of aluminum when exposed to oxygen in the air; this oxide requires a temperature of 3700°F to melt or break down

    (NOTE: At welding temperatures, oxygen in the air combines with the exposed aluminum to reform the oxide. With inert gas to shield the weld zone and the reverse polarity cycle of AC current to remove the oxide, the problem is illiminated.)

    3. Heat colors--Aluminum shows no heat colors as it approaches the melting point

    (NOTE: With the GTAW process, the metal takes on a shiny or wet appearance when melting occurs.)

    4. Proper mechanical support--Since some aluminum alloys melt at 900°F, care must be taken to support all areas subjected to the extreme heat of welding to prevent collapse, warping, and distortion

  B. Stainless steel

    1. Thermal conductivity--Stainless steel dissipates heat from the weld zone forty to fifty percent slower than mild steel

    2. Distortion--Heat expansion in the weld zone is so slow, weld metal warpage is a problem

    (NOTE: Jigs and backup bars can be used to effectively dissipate the heat from the weld zone and thereby reduce stresses and warpage, plus improve the mechanical properties of the weld.)

XI. Causes of poor welds (Transparency 6)

  A. Welding current too low

  B. Welding current too high

INFORMATION SHEET

   C. Arc too long
   D. Welding speed too fast
   E. Welding speed too slow
   F. Contaminated tungsten

XII. Characteristics of a good weld (Transparency 7)

   A. Smooth edge
   B. Correct bead size
   C. Even penetration
   D. Even ripple
   E. Clean bright weld

XIII. Characteristics of argon and helium

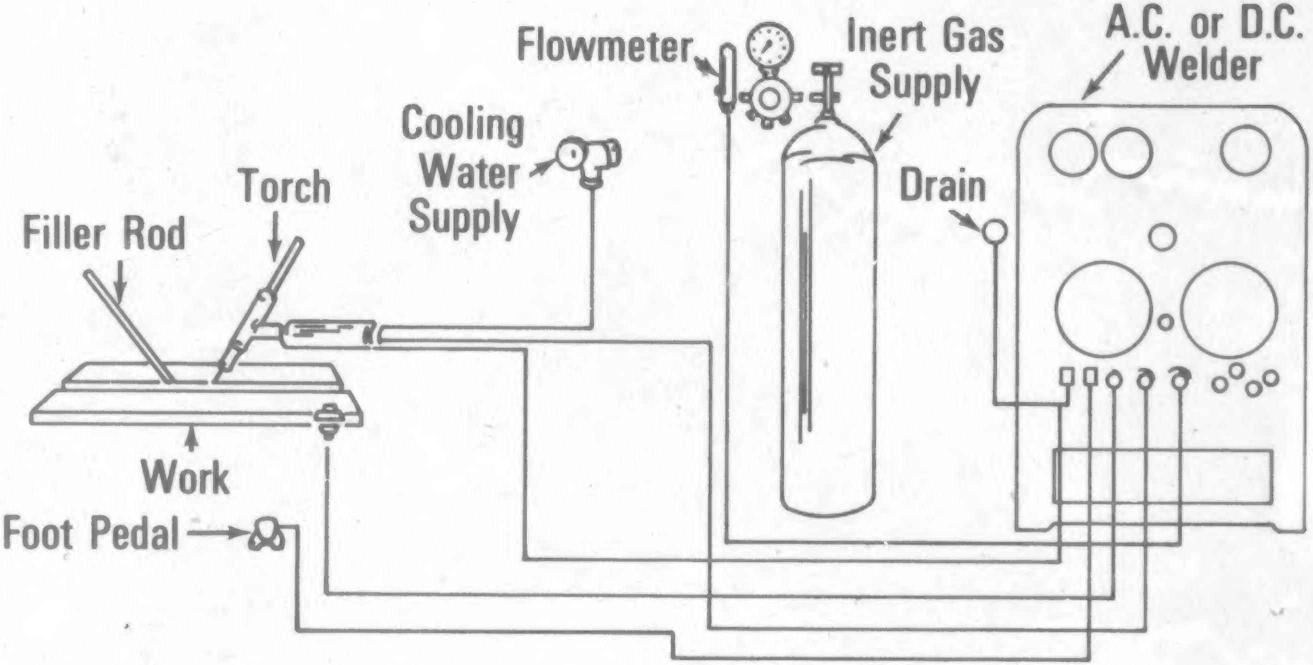
   A. Argon--Most popular gas for GTAW
      1. Easily obtainable at low cost
      2. Better shielding at lower flow rates (c. f. h.) than helium

         (NOTE: Argon is ten times heavier than helium)
      3. Easier arc starting than helium
      4. Better cleaning action when welding aluminum with AC current

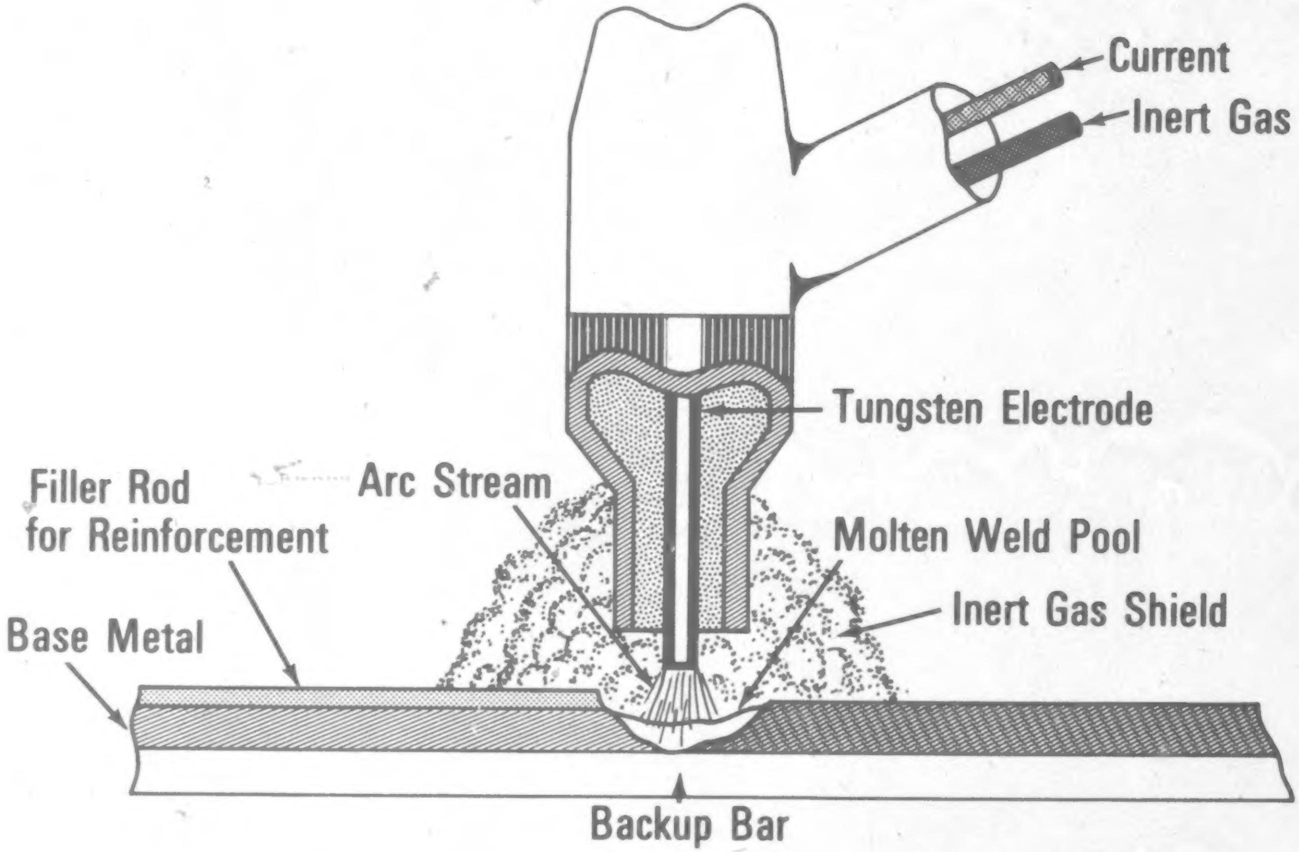
   B. Helium--Used when welding thicker metals
      1. Yields higher heat for comparable current than argon
      2. Arc length is more critical than argon
      3. Has higher welding speeds than argon
      4. Produces poor arc stability and cleaning action

   (NOTE: Argon-Helium mixes are used when excellent cleaning and high heat input is needed for thick plates.)

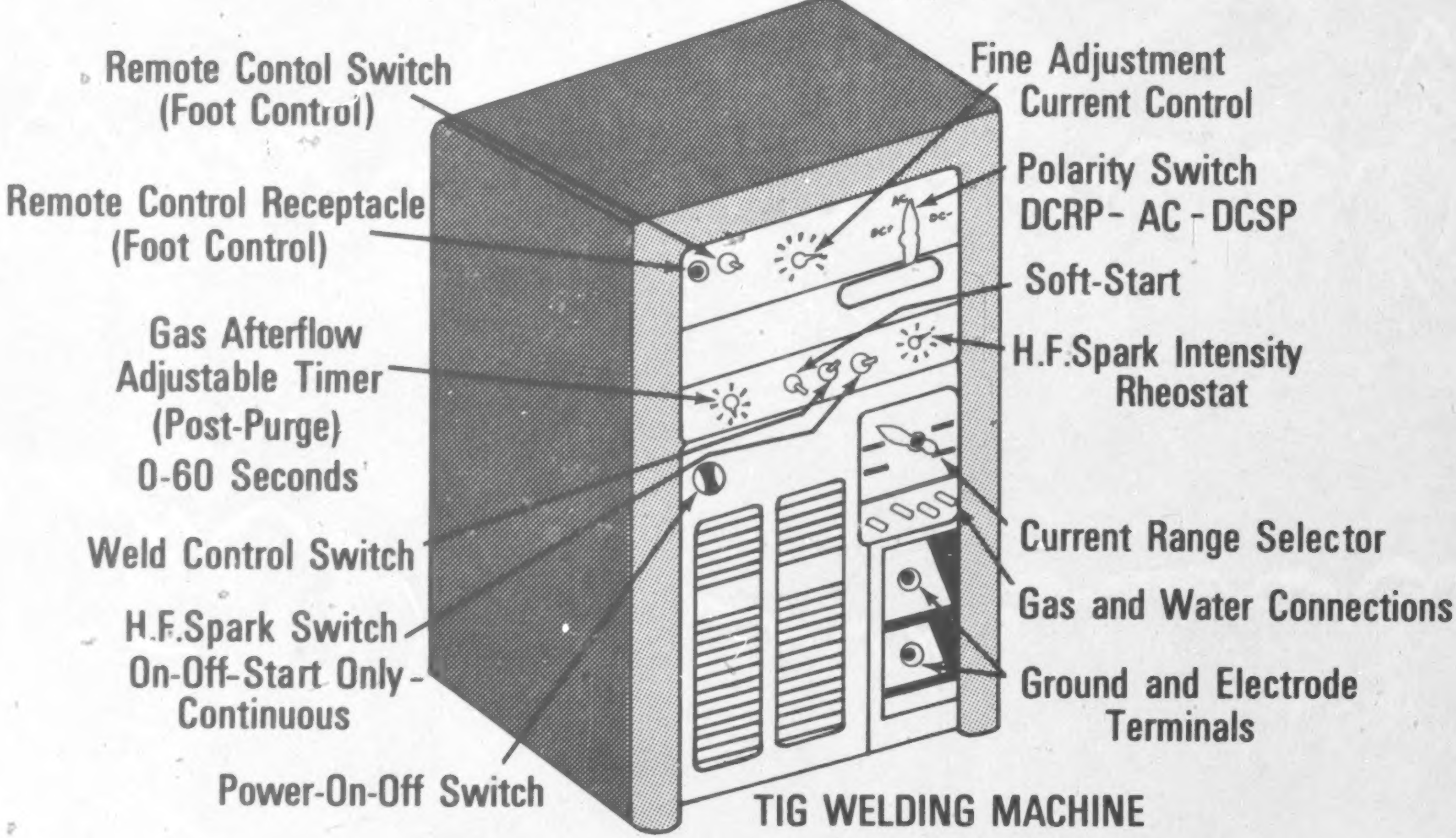
GTAW Equipment


Flowmeter
Inert Gas Supply
A.C. or D.C. Welder
Cooling Water Supply
Torch
Filler Rod
Drain
Work
Foot Pedal

GTAW Process

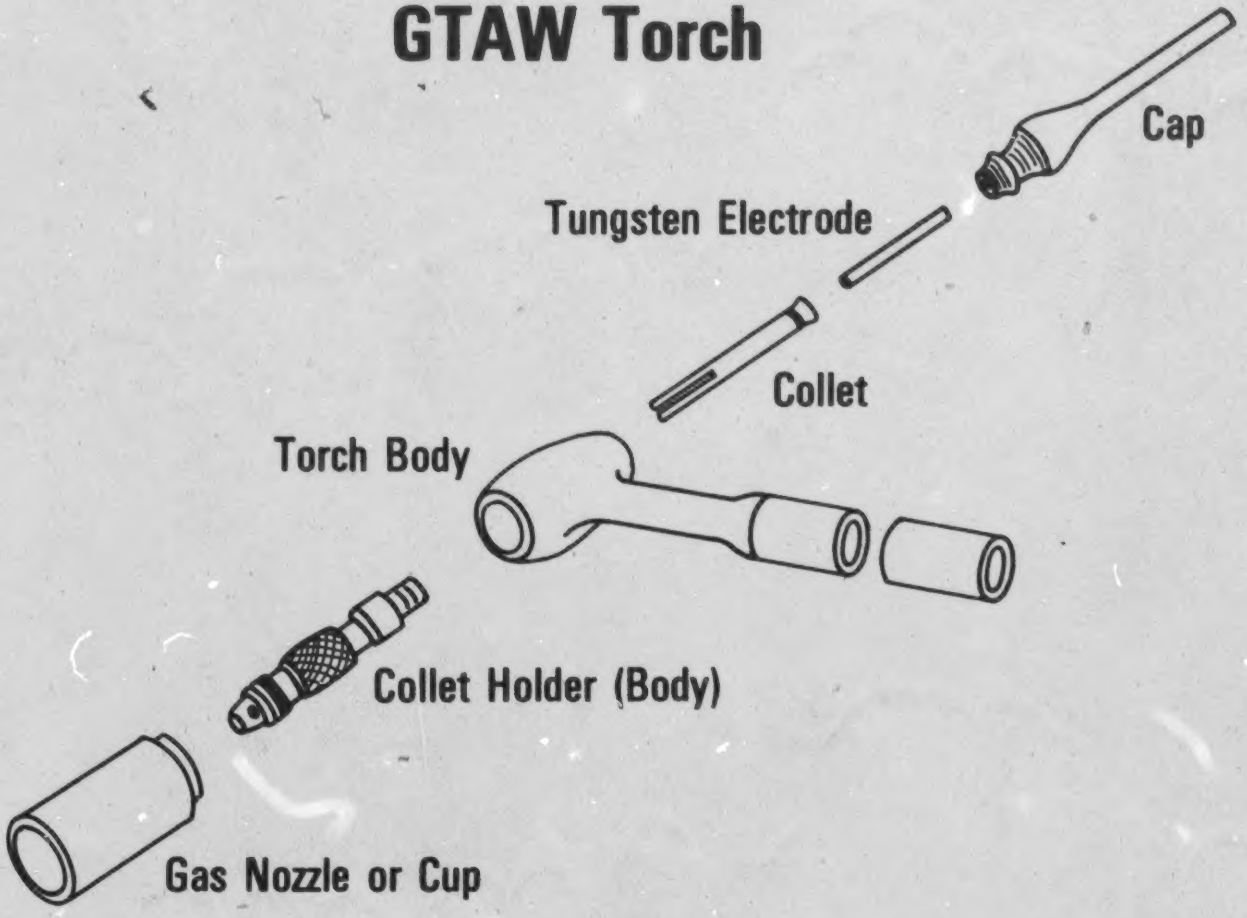

Current
Inert Gas
Tungsten Electrode
Filler Rod
for Reinforcement
Arc Stream
Molten Weld Pool
Inert Gas Shield
Base Metal
Backup Bar

GTAW Power Supply


Remote Contol Switch
(Foot Control)
Remote Control Receptacle
(Foot Control)
Gas Afterflow
Adjustable Timer
(Post-Purge)
0-60 Seconds
Weld Control Switch
H.F.Spark Switch
On-Off-Start Only -
Continuous
Power-On-Off Switch
Fine Adjustment
Current Control
Polarity Switch
DCRP- AC - DCSP
Soft-Start
H.F.Spark Intensity
Rheostat
Current Range Selector
Gas and Water Connections
Ground and Electrode
Terminals

TIG WELDING MACHINE

GTAW Torch

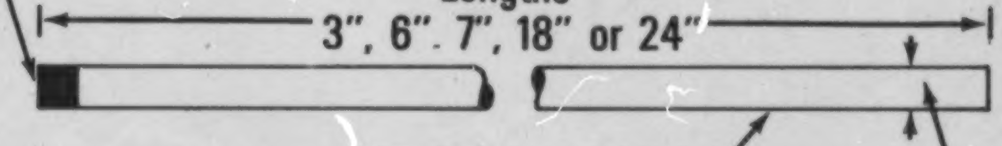

Cap
Tungsten Electrode
Collet
Torch Body
Collet Holder (Body)
Gas Nozzle or Cup

GTAW Electrodes

TUNGSTEN ELECTRODES

Electrodes Available

Color Code	Metal or Alloy
Green	Pure Tungsten
Yellow	1% Thorium
Red	2% Thorium
Brown	Zirconium



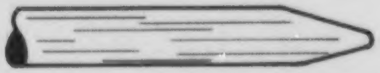
Lengths
3", 6". 7", 18" or 24"

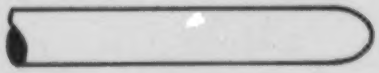
Finish
Chemically Etched
Ground

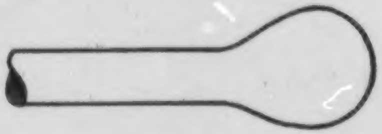
Standard Diameters
Finishes and Lengths
1/16", 3/32", 1/8", 5/32", 3/16", and 1/4"

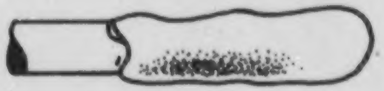
GTAW Electrodes

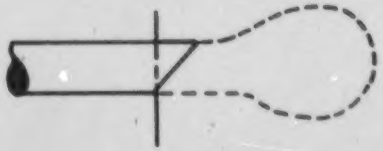
PREPARE ELECTRODE

A  Good Condition- Pull point-with grind marks running lengthwise-(steel & stainless)

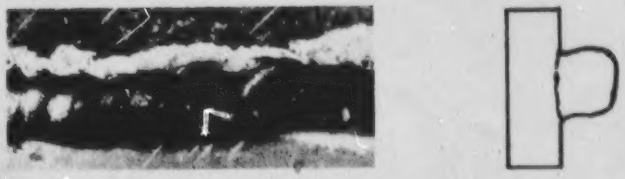
B  Good Condition- Shiny, round end-(aluminum & magnesium)

C  Too Much Current- Match head shape

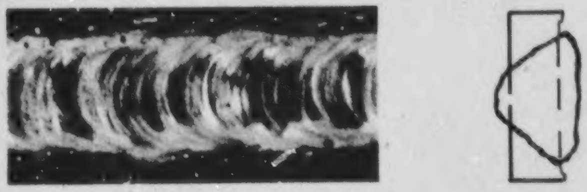
D  End Contaminated With Base Metal-
Electrode touched puddle or filler rod
(similar to C, but uneven and longer)

E  Break off ends at dotted lines, if condition C or D exists. If electrode breaks at angle, grind off flat.

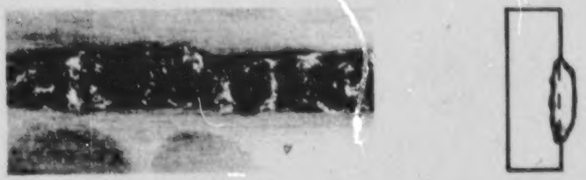
Causes of Poor Welds



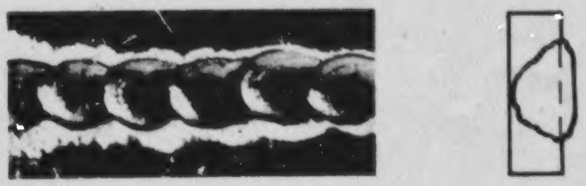
Welding Current Too Low



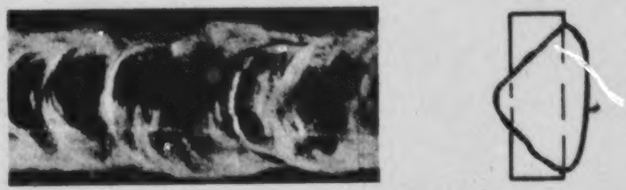
Welding Current Too High



Arc Too Long (voltage too high)

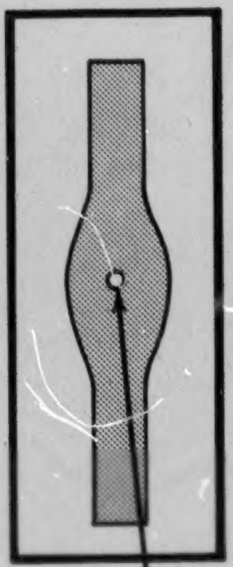


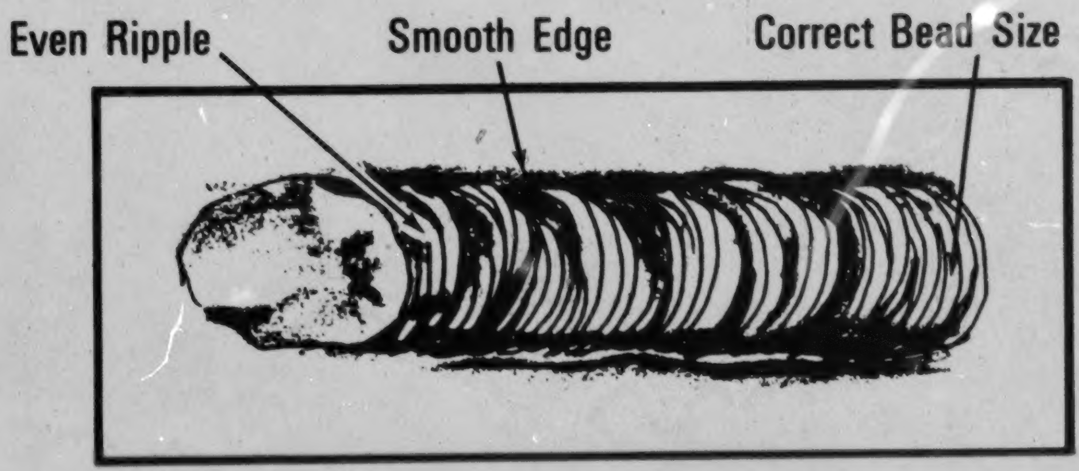
Welding Speed Too Fast



Welding Speed Too Slow

Example of a Good Weld


Even Penetration


Even Ripple
Smooth Edge
Correct Bead Size

Clean, Bright Weld

GAS TUNGSTEN ARC WELDING
UNIT I

ASSIGNMENT SHEET #1–ALUMINUM FILLER METALS

Using the aluminum chart. in the information sheet, answer the following questions:

1. What filler metal should be used to weld base metal 3004?

   ____

2. What filler metal should be used to weld base metals 6061, 6062, 6063, and 6151? ___________

3. What type of filler metal would be required for 5456?

   ____

4. What filler metal would be used for 5052 base metal? ___________

5. For base metal 3003, you would use ___________ filler metal.

GAS TUNGSTEN ARC WELDING
UNIT I

ASSIGNMENT SHEET #2--STAINLESS STEEL FILLER METALS

Using the stainless steel chart in the information sheet, answer the following questions.

1. For welding type 304 stainless, what would be the correct filler rod? ___________ How much chromium does it contain Cr__________.
2. Type 347 stainless requires type __________ filler rod.
3. Type 316L stainless requires type ___________ filler rod.
4. Type 308 stainless requires type ___________ filler rod.
5. Type 310 filler metal will be used on type _____ _____ base metal.

GAS TUNGSTEN ARC WELDING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. 4043
2. 5356
3. 5556
4. 5652
5. ER1100

Assignment Sheet #2

1. 308L--20.6
2. 347
3. 316L
4. 308L
5. 310

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #1--SET UP AND SHUT DOWN POWER SUPPLY FOR WELDING ALUMINUM

I. Equipment and materials

- A. GTAW power supply with water cooled torch and foot control
- B. Argon--Shielding gas
- C. Pure or zirconiated tungsten
- D. Collet and collet chuck (body)
- E. Nozzle
- F. Aluminum filler rod
- G. Aluminum--Welding grade

II. Procedure

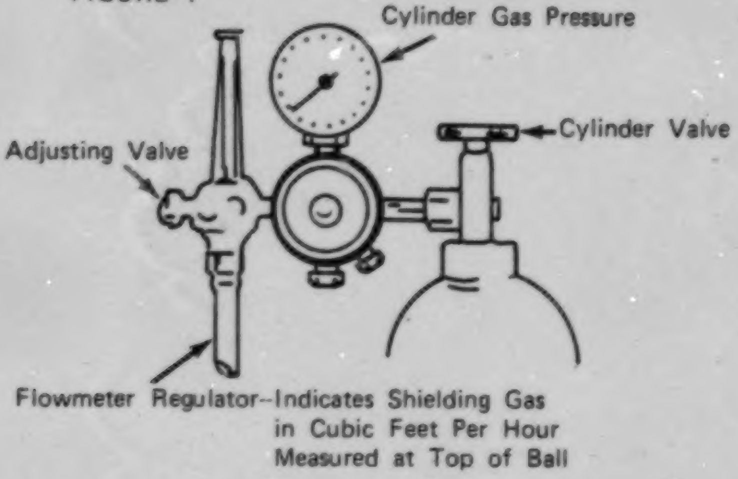
- A. Set up power supply
  - 1. Set current range selector--Low, medium, or high--Depends on metal thickness
    - a. Low--2-60 amps
    - b. Medium--10-250 amps
    - c. High--20-300 amps
  - 2. Fine control to maximum within each range
  - 3. Set polarity switch to AC
  - 4. Set weld control switch to GTAW
  - 5. Set high frequency control to
    - a. Continuous
    - b. Intensity--Spark control to medium
  - 6. Switch power to "on" position
  - 7. Mount flowmeter to argon cylinder
    - a. Crack cylinder slowly
    - b. Check for leaks using ivory soap

JOB SHEET #1

c. Mount in vertical position

(NOTE: This is accurate only if gas in cylinder exceeds 50 p.s.i.) (Figure 1)

FIGURE 1


Cylinder Gas Pressure
Cylinder Valve
Adjusting Valve
Flowmeter Regulator--Indicates Shielding Gas in Cubic Feet Per Hour Measured at Top of Ball

8. Adjust shielding gas flow rate (cubic foot hour)

   (NOTE: Measured at the top of ball.)

9. Adjust post purge (gas afterflow) timer to 15 seconds (1-60 seconds)

10. Set soft start to "on" position

11. Set foot control switch to remote

JOB SHEET #1

B. Torch adjustments

1. Select pure or zirconiated tungsten of correct size

2. Prepared tungsten should have a shiny balled end (Figure 2)

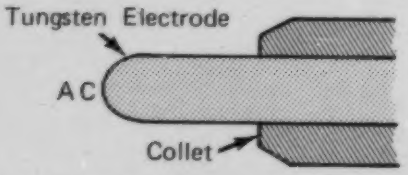
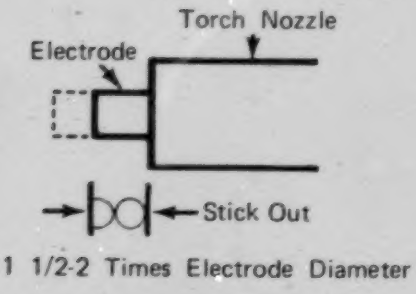

Tungsten Electrode
AC
Collet

FIGURE 2

3. Select correct size collet, collet chuck, and cup or nozzle

4. Adjust electrode stick out (Figure 3)

FIGURE 3


Torch Nozzle
Electrode
Stick Out
1 1/2-2 Times Electrode Diameter

(NOTE: Stick out distance can be increased when welding T-joints, groove welds, or other hard to reach joints. Gas flow rates should be increased accordingly.)

C. Connect ground clamp to base metal

JOB SHEET #1

D. Select correct filler rod size from chart below

GAS TUNGSTEN ARC (TIG) WELDING OF ALUMINUM

Material Thickness		Type of Weld (2)	Tungsten Electrode Dia. (3)	Filler Rod Dia. (4)	Nozzle Size I.D.	Shielding Gas C.F.H. (5)	Welding Current (Amps) AC-HF	Number of Passes	Travel Speed (I.P.M.)
3/64,	.046	Sq. groove	1/16	1/16	1/4	19	40-60	1	16
1/16,	.063	Sq. groove	3/32	3/32	5/16	19	70-90	1	11
1/16,	.063	Fillet	3/32	3/32	5/16	15	70-90	1	9
3/32,	.094	Sq. groove	3/32	3/32	5/16	19	90-110	1	11
3/32,	.094	Fillet	3/32	3/32	5/16	16	95-115	1	9
1/8,	.125	Sq. groove	1/8	1/8	3/8	20	115-135	1	11
1/8,	.125	Fillet	1/8	1/8	3/8	19	120-140	1	10
3/16	.187	Fillet	5/32	5/32	7/16	25	180-200	1	10
3/16	.187	V – groove	5/32	5/32	7/16	25	160-180	2	11
1/4	.250	Fillet	3/16	3/16	1/2	30	230-250	1	10
1/4	.250	V – groove	5/32	5/32	7/16	30	200-220	2	9
3/8	.375	Fillet	3/16	3/16	1/2	35	250-310	2-3	

1. Increase amperage when backup is used.

2. Data is for all welding positions.

3. For tungsten electrodes - 1st choice - pure tungsten green strip; 2nd choice - zirconated brown strip.

4. Normally Argon is used for shielding, however, mixtures of 10% or more helium with Argon are sometimes used for increased penetration in aluminum 1/4 inch thick and over. The gas flow should be increased when helium is added. A mixture of 75% He + 25% Argon is popular. When 100% helium is used, gas flow rates are about twice those used for Argon.

Courtesy of Hobart Brothers Technical Center, Troy, Ohio.

JOB SHEET #1

E. Shut down power supply

1. Place torch where it will not arc or fall in floor

   (NOTE: GTAW torch is delicate and should be handled with care.)

2. Close gas cylinder valve

3. Depress foot control to bleed gas line

4. Close gas flow adjusting valve

   (NOTE: Ball will rest at bottom of gauge.)

5. Shut off power switch

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #2--SET UP AND SHUT DOWN POWER SUPPLY FOR WELDING MILD AND STAINLESS STEEL

I. Equipment and materials

  A. GTAW power supply with water cooled torch with or without foot control

  B. Argon--Shielding gas

  C. 1-2% thoriated tungsten

  D. Collet and collet chuck (body)

  E. Correct nozzle size

  F. Stainless and mild steel filler rod

II. Procedure

  A. Set up power supply

    1. Set current range selector to

      a. Low, medium, or high--Depends on metal thickness

      b. Maximum if foot control is used

    2. Set current selector to DCSP

    3. Set weld control switch to GTAW

    4. Set high frequency control to

      a. Start only if this on control is on machine

      (NOTE: If this control is not on the machine, check with instructor.)

      b. Intensity--Spark control to medium

    (NOTE: Power supply not equipped with high frequency will not have these controls. If power supply does not have high frequency, it will be necessary to have a copper starting block to avoid contamination of tungsten when striking arc.)

    5. Switch power to "on" position

JOB SHEET #2

6. Mount flowmeter to argon cylinder

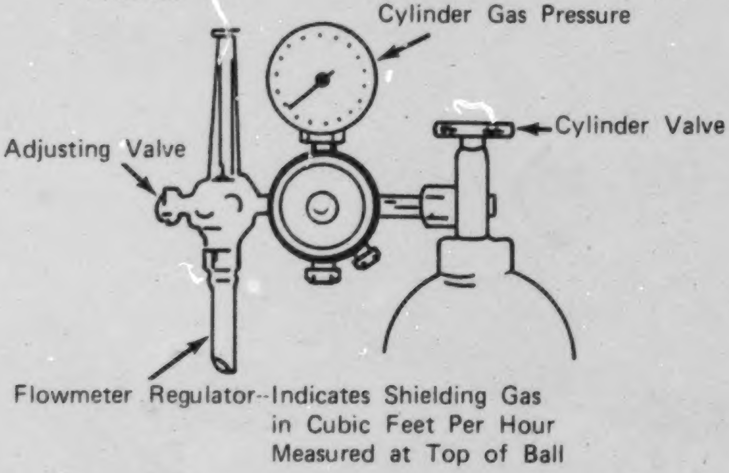
   a. Crack cylinder slowly

   b. Check for leaks using ivory soap

   c. Mount in vertical position

   (NOTE: This is accurate only if gas in cylinder exceeds 50 p.s.i.) (Figure 1)

FIGURE 1


Cylinder Gas Pressure
Cylinder Valve
Adjusting Valve
Flowmeter Regulator--Indicates Shielding Gas in Cubic Feet Per Hour Measured at Top of Ball

7. Adjust shielding gas flow rate (cubic foot hour)

   (NOTE: Measured at the top of ball.)

8. Adjust post purge (gas afterflow) timer to 15 seconds (1-60 seconds)

9. Set soft start switch to "off" position

10. Set foot control switch to remote (if equipped)

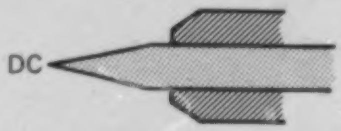
B. Torch adjustments

   1. Select a 1 or 2% thoriated tungsten of correct size

JOB SHEET #2

2. Prepared tungsten should be ground to a dull point with grinding done lengthwise with the tungsten (Figure 2)

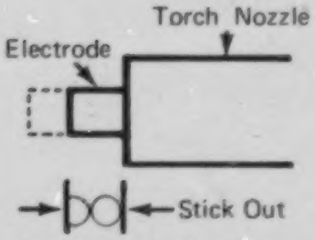
FIGURE 2



3. Select correct size collet, collet chuck, and gas cup (nozzle)

4. Adjust electrode stick out (Figure 3)

FIGURE 3



1 1/2-2 Times Electrode Diameter

(NOTE: Stick out distance may be increased when welding in hard to reach joints. Gas flow rates should be increased accordingly.)

C. Connect ground clamp to base metal

D. Select correct filler rod type and size for mild and stainless steel from the following charts

GAS TUNGSTEN ARC (TIG) WELDING OF CARBON AND LOW ALLOY STEEL

Material Thickness		Type of Weld (2)	Tungsten Electrode Dia. (3)	Filler Rod Dia. (4)	Nozzle Size I.D.	Shielding Gas C.F.H.(5)	Welding Current (Amps) DCSP	Number of Passes	Travel Speed (I.P.M.)
20 ga.	.032"	Sq. groove & Fillet	1/16	1/16	1/4	10	75-100	1	13
18 ga.	.040"	Sq. groove & Fillet	1/16	1/16	1/4	10	90-120	1	15
16 ga.	.063"	Sq. groove & Fillet	1/16	1/16	1/4	10	95-135	1	15
3/32	.094"	Sq. groove & Fillet	3/32	3/32	5/16	10	135-175	1	14
1/8	.125"	Sq. groove & Fillet	3/32	1/8	5/16	12	145-205	1	11

1. Increase amperage when backup is used.
2. Data is for all welding positions.
3. For tungsten electrode, 1st choice - 2% thoriated; 2nd choice - 1% thoriated
4. Shielding gas is Argon: The 75% Helium 25% Argon mixture is sometimes used for heavier thicknesses.

Courtesy of Hobart Brothers Technical Center, Troy, Ohio.

GAS TUNGSTEN ARC (TIG) WELDING OF STAINLESS STEEL

Material Thickness	Type of Weld	Tungsten Electrode Dia. (3)	Filler Rod Dia. (4)	Nozzle Size I.D.	Shielding Gas C.F.H. (5)	Welding Current (Amps) DCSP	Number of Passes	Travel (6) Speed (I.P.M.)
24 ga.	Square groove	.040	1/16	1/4	10	20-50	1	26
18 ga.	"	1/16	1/16	1/4	10	50-80	1	22
1/16	"	1/16	1/16	1/4	12	65-105	1	12
1/16	Fillet	1/16	1/16	1/4	12	75-125	1	10
3/32	Square groove	1/16	3/32	1/4	12	85-125	1	12
3/32	Fillet	1/16	3/32	1/4	12	95-135	1	10
1/8	Square groove	1/16	3/32	5/16	12	100-135	1	12
1/8	Fillet	1/16	3/32	5/16	12	115-145	1	10
3/16	Square groove	3/32	1/8	5/16	15	150-225	1	10
3/16	Fillet	1/8	1/8	3/8	15	175-250	1	8
1/4	V-groove	1/8	3/16	3/8	18	225-300	2	10
1/4	Fillet	1/8	3/16	3/8	18	225-300	2	10
3/8	V-groove	3/16	3/16	1/2	25	220-350	2-3	10
3/8	Fillet	3/16	3/16	1/2	25	250-350	3	10
1/2	V-groove	3/16	1/4	1/2	25	250-350	3	10
1/2	Fillet	3/16	1/4	1/2	25	250-350	3	10

1 - Increase amperage when backup is used.

2 - Data is for flat position. Reduce amperage 10% to 20% when welding is horizontal, vertical, or overhead position.

3 - For tungsten electrodes - 1st choice 2% thoriated; 2nd choice 1% thoriated.

4 - Argon is used for shielding. The 75% helium 25% argon mixture is used for heavier thicknesses.

5 - Travel speed per pass of multi-pass weld.

Courtesy of Hobart Brothers
Technical Center, Troy, Ohio.

JOB SHEET #2

E. Shut down power supply

1. Place torch where it will not arc or fall in floor

   (NOTE: GTAW torches are delicate, expensive, and should be handled with care.)

2. Close gas cylinder valve

3. Depress foot control (if equipped) to bleed gas line

4. Close gas flow adjusting valve

   (NOTE: Ball will rest at bottom of gauge.)

5. Shut off power switch

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #3--METAL PREPARATION OF ALUMINUM, STAINLESS, AND MILD STEEL BEFORE WELDING

I. Equipment and materials

A. Metals--Aluminum, stainless steel, and mild steel (welding grades)

B. Stainless steel brush

C. Sand blasting equipment, if available

D. Milling or grinding machines available

E. Portable grinder

F. Pedestal grinder with wire brush

G. Chemical solutions

H. Files for aluminum and steel

II. Procedures

A. Cleaning aluminum

1. Scrub all joint surfaces to be welded with a clean stainless steel brush to remove dirt, paint, metal particles, and the oxide coating

2. File the joint edges to remove the oxide coating

3. Dip metal into a five percent solution of sodium hydroxide at 160°F for 60 seconds

4. Follow by dipping metal into a solution of equal parts of nitric acid and water at room temperature

5. Metal should be rinsed with water and air dryed

(NOTE: The chemical method is most effective in removing dirt, paint, metal particles, oil and grease, and the oxide coating.)

(CAUTION: Aluminum must be clean and all cleaning should take place immediately prior to welding to avoid the oxide that will reform.)

JOB SHEET #3

B. Cleaning stainless steel

1. Scrub all joint surfaces with a stainless steel brush to remove all dirt, paint, and metal particles

2. Sandblasting can be used to remove dirt, paint, moisture, and metal particles

   (NOTE: Sand must be clean.)

3. Machine or grind joint edges for desired edge preparation and for removal of dirt and paint

4. Dip in a solution of 10-20% nitric acid to remove all dirt, oil and grease, moisture, and metal particles

5. Rinse with water and allow to air dry thoroughly before welding

C. Cleaning mild s[illegible]

1. Grind edges of joints to remove all mill scale, rust, dirt, paint, and metal particles

2. File edges if grinder is not available

3. Sandblast edges of joints to remove mill scale, rust, dirt, paint, and metal particles

4. Wirebrush to remove rust, dirt, paint, and metal particles

5. Wash metal down with a solvent solution to remove dirt, oil, grease, and metal particles

   (NOTE: Hot roll steel from the mill will have mill scale whereas cold roll steel will have an oil coating. Both should be removed before welding.)

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #4--MAKE STRINGER BEADS ON ONE-SIXTEENTH INCH ALUMINUM WITH FILLER ROD IN THE FLAT POSITION

I. Equipment and materials

   A. GTAW power supply and required equipment

   B. Personal protective equipment

   C. Stainless steel wire brush (clean)

   D. Filler rod 3/32"

   E. Pure tungsten electrode 3/32", collet, and collet body

   F. Argon shielding gas 15-20 c.f.h.

   G. Two pieces, 1/16", 2" x 6" aluminum

II. Procedure

   A. Clean aluminum with stainless wire brush to remove oxide coating

   B. Check torch for the following

      1. Nozzle cup size 5/16" inside diameter

         a. Unburnt

         b. Even end with no cracks or chips

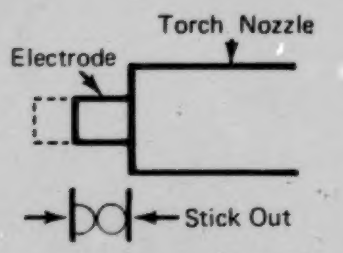
      2. Correct collet and collet body--3/32"

      3. Correct tungsten with the following

         a. Round shiny end

         b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

         c. Finger tighten cap to secure tungsten

JOB SHEET #4

C. Attach ground clamp

D. Set welding machine and turn on power

   1. AC current

   2. Current adjustment

      a. Coarse adjustment--middle range 10-250

      b. Fine adjustment--maximum

E. Set high frequency

   1. Continuous operation

   2. Rheostat to medium

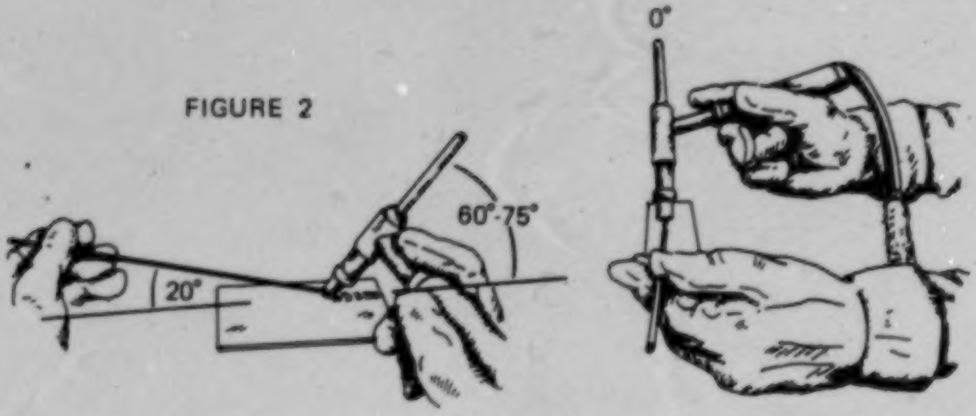
F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position metal flat on table

I. Position torch at 160°-75° angle to metal with no side angle (Figure 2)

FIGURE 2



Weldor's View

End View

J. Hold electrode 1/16" from metal (See Figure 2.)

K. Hold filler rod at 20° angle to metal with no side angle (See Figure 2.)

JOB SHEET #4

L. Depress foot control at least half-way and establish arc and immediate puddle

(NOTE: Do not contact metal or filler rod with tungsten.)

M. Add filler rod in leading edge of puddle being careful to keep rod under shielding gas at all times

(NOTE: Consistent travel speed and addition of filler rod is the key to producing uniform beads of correct height and width.)

N. After each pass, switch or cool metal being careful to remove all moisture before welding

O. Have instructor inspect workpiece

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #5--CONSTRUCT A SQUARE GROOVE BUTT WELD ON ONE-EIGHTH INCH ALUMINUM IN THE FLAT POSITION

I. Equipment and materials

   A. GTAW power supply and required equipment

   B. Personal protective equipment

   C. Stainless steel wire brush (clean)

   D. Filler rod 1/8"

   E. Pure tungsten electrode 1/8" green strip

   (NOTE: One-eighth inch electrode requires a 1/8" collet and collet body.)

   F. Argon shielding gas 20 c.f.h.

   G. Material 2 - 1/8" x 2" x 6" aluminum

II. Procedure

   A. Clean aluminum with stainless wire brush to remove oxide coating

   B. Check torch for the following

      1. Nozzle (cup) size 3/8" inside diameter

         a. Unburnt

         b. Even end with no cracks or chips

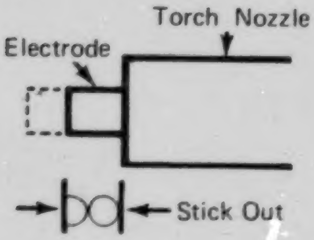
      2. Correct collet and collet body--1/8"

      3. Correct tungsten with the following

         a. Round shiny end

         b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

         c. Finger tighten cap to secure tungsten

JOB SHEET #5

C. Attach ground clamp

D. Set welding machine and turn on power

   1. AC current

   2. Current adjustment

      a. Coarse adjustment--middle range 10-250

      b. Fine adjustment--maximum

E. Set high frequency

   1. Continuous operation

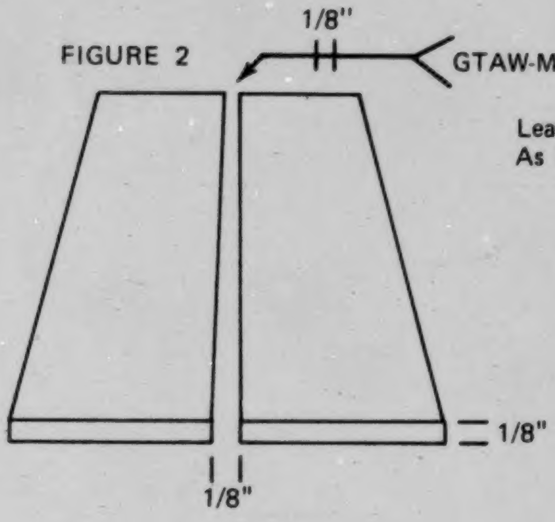
   2. Rheostat to medium

F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position two pieces of aluminum to form a butt joint leaving a 3/32"-1/8" root opening (Figure 2)

FIGURE 2

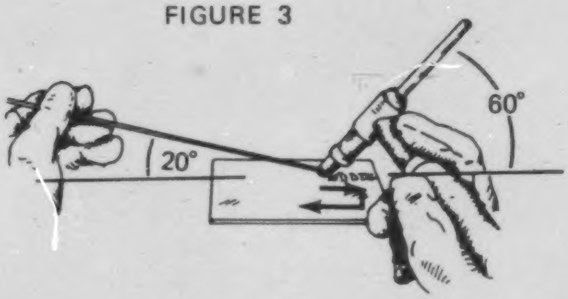


Leave Root Opening Between Plates As Wide As Material Is Thick

JOB SHEET #5

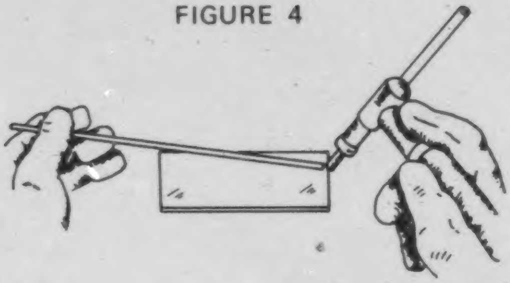
I. Position torch at a 60° angle to metal with no side angle and centered in joint (Figure 3)

FIGURE 3



J. Hold electrode 1/16" from metal (Figure 4)

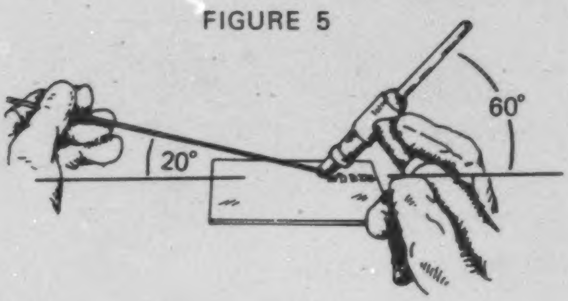
FIGURE 4



JOB SHEET #5

K. Position filler rod at a 20° to metal and centered in root opening of joint (Figure 5)

FIGURE 5



L. Depress foot control, establish arc, and tack each end

M. Move to end of joint, strike arc, and establish puddle by melting rod and both plate edges

(NOTE: As weld progresses, care should be taken to maintain consistent travel speed, torch and rod angle, and correct arc length.)

N. Amperage should be decreased slowly with additional filler rod added to prevent crater at the end of bead

O. Check root of weld for penetration and cool metal before welding other side

P. Check your work with instructor

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #6--MAKE A LAP JOINT FILLET WELD ON ONE-EIGHTH INCH ALUMINUM WITH FILLER ROD IN THE HORIZONTAL POSITION

I. Equipment and materials

  A. GTAW power supply and required equipment

  B. Personal protective equipment

  C. Stainless steel wire brush (clean)

  D. Filler rod 1/8"

  E. Pure tungsten electrode 3/32" green strip (See chart 3.)

  (NOTE: Three-thirty-second inch electrode requires a 3/32" collet and collet body.)

  F. Argon shielding gas 15-20 c.f.h.

  G. Two pieces, 1/8" x 2" x 6" aluminum

II. Procedure

  A. Clean aluminum with stainless wire brush to remove oxide coating

  B. Check torch for the following

    1. Nozzle (cup) size 3/8" inside diameter

      a. Unburnt

      b. Even end with no cracks or chips

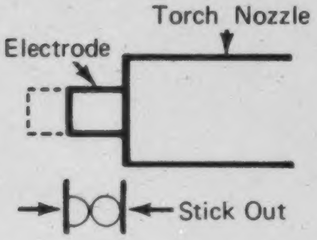
    2. Correct collet and collet body

    3. Correct tungsten with the following

      a. Round shiny end

      b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

JOB SHEET #6

        c. Finger tighten cap to secure tungsten

C. Attach ground clamp

D. Set welding machine and turn on power

    1. AC current

    2. Current adjustment

        a. Coarse adjustment--middle range 10-250

        b. Fine adjustment--maximum

E. Set high frequency

    1. Continuous operation

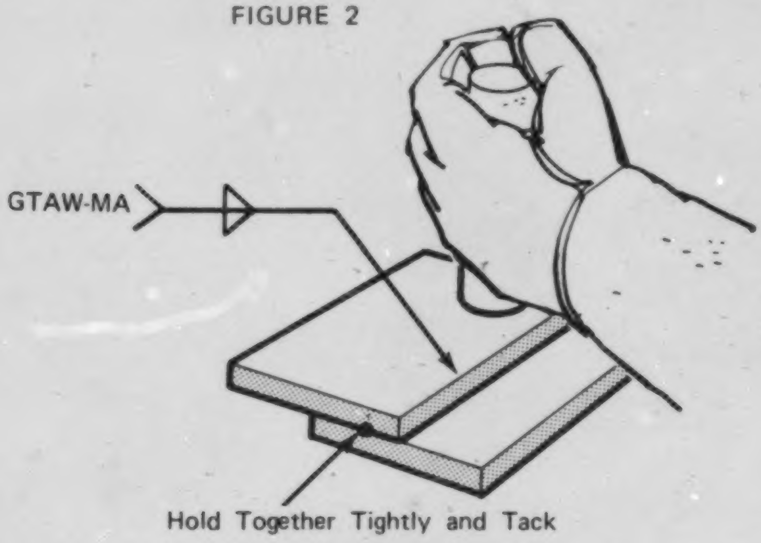
    2. Rheostat to medium

F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position two pieces of aluminum to form a lap joint as indicated (Figure 2)

FIGURE 2



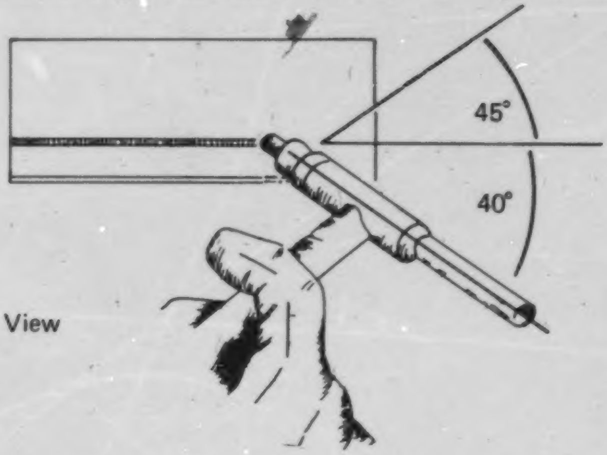
Hold Together Tightly and Tack

I. Tack both ends of joint with filler rod as indicated

JOB SHEET #6

J. Position torch at a 45° angle from table with a 40° side angle toward you (Figure 3)

FIGURE 3

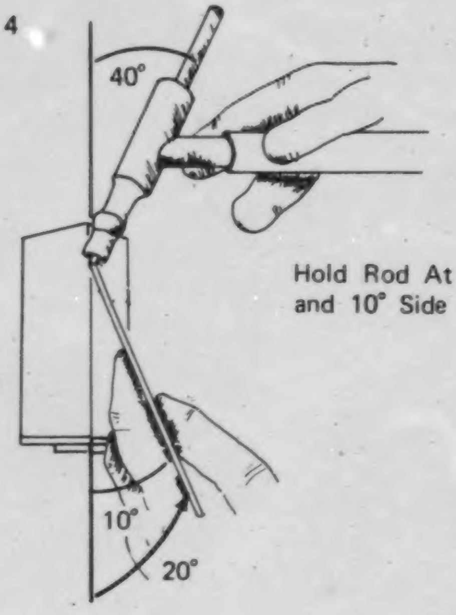


Weldor's View

(NOTE: It may be helpful to extend electrode stick out 1/16"-1/8" to improve penetration to bottom of joint. Increase gas flow rate.)

K. Hold filler rod at a 20° angle from table with a 10° side angle toward you (Figure 4)

FIGURE 4



Hold Rod At 20° Angle from Table and 10° Side Angle (Toward You)

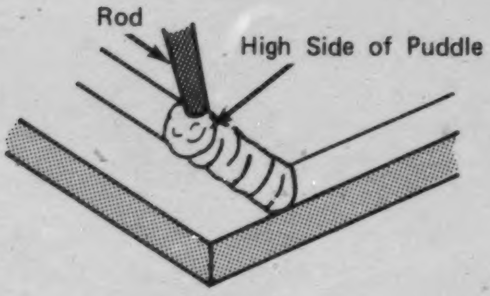
End View

JOB SHEET #6

L. Start arc, then move torch back to end of joint and form puddle

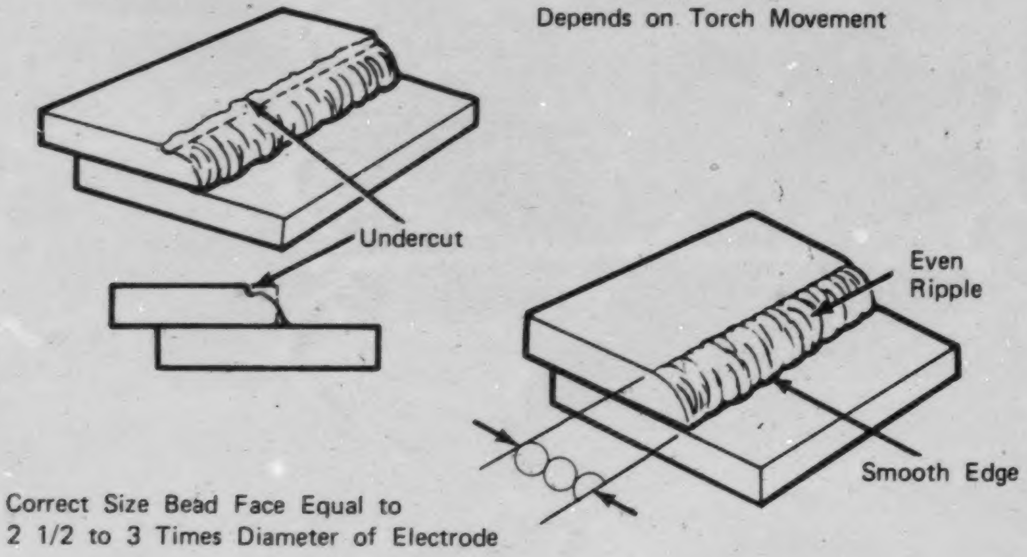
M. Dip filler rod in and out at high side of leading edge of puddle to prevent undercutting (Figure 5)

FIGURE 5


Rod
High Side of Puddle

N. Inspect weld for undercutting and correct bead size with even ripples (Figure 6) and complete penetration (Figure 7)

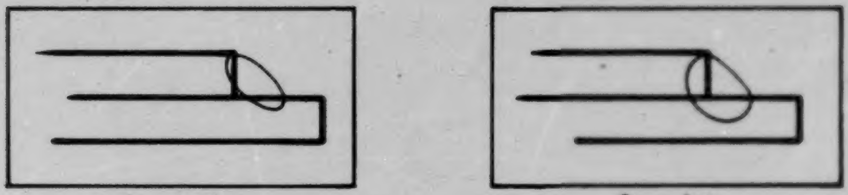
FIGURE 6


Undercutting
Depends on Torch Movement
Undercut
Even
Ripple
Smooth Edge
Correct Size Bead Face Equal to
2 1/2 to 3 Times Diameter of Electrode

JOB SHEET #6

FIGURE 7

Penetration



Incomplete Complete

O. Cool and dry metal after each pass

P. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #7--CONSTRUCT A CORNER JOINT FILLET WELD ON ONE-EIGHTH INCH ALUMINUM WITHOUT FILLER ROD IN THE FLAT POSITION

I. Equipment and materials

  A. GTAW power supply and required equipment

  B. Personal protective equipment

  C. Stainless steel wire brush (clean)

  D. Pure tungsten electrode 3/32" green strip (See chart 3.)

  (NOTE: Three-thirty-second inch electrode requires a 3/32" collet and collet body.)

  E. Argon shielding gas 15-20 c.f.h.

  F. Two pieces, 1/8" x 2" x 6" aluminum

II. Procedure

  A. Clean aluminum with stainless wire brush to remove oxide coating

  B. Check torch for the following

    1. Nozzle (cup) size 3/8" inside diameter

      a. Unburnt

      b. Even end with no cracks or chips

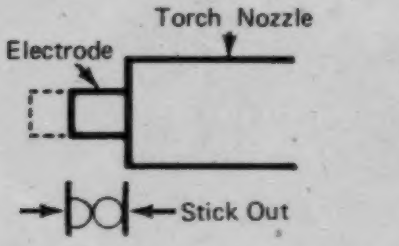
    2. Correct collet and collet body--1/8"

    3. Correct tungsten with the following

      a. Round shiny end

      b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

JOB SHEET #7

c. Finger tighten cap to secure tungsten

C. Attach ground clamp

D. Set welding machine and turn on power

1. AC current

2. Current adjustment

a. Coarse adjustment--middle range 10-250

b. Fine adjustment--maximum

E. Set high frequency

1. Continuous operation

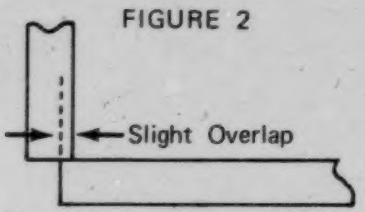
2. Rheostat to medium

F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position two pieces of aluminum to form a right angle overlapping slightly (Figure 2)

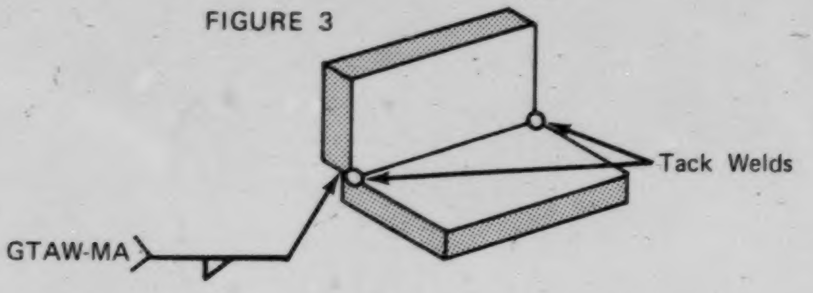
FIGURE 2



Hold Pieces Firmly in Place

I. Tack each end of joint as indicated (Figure 3)

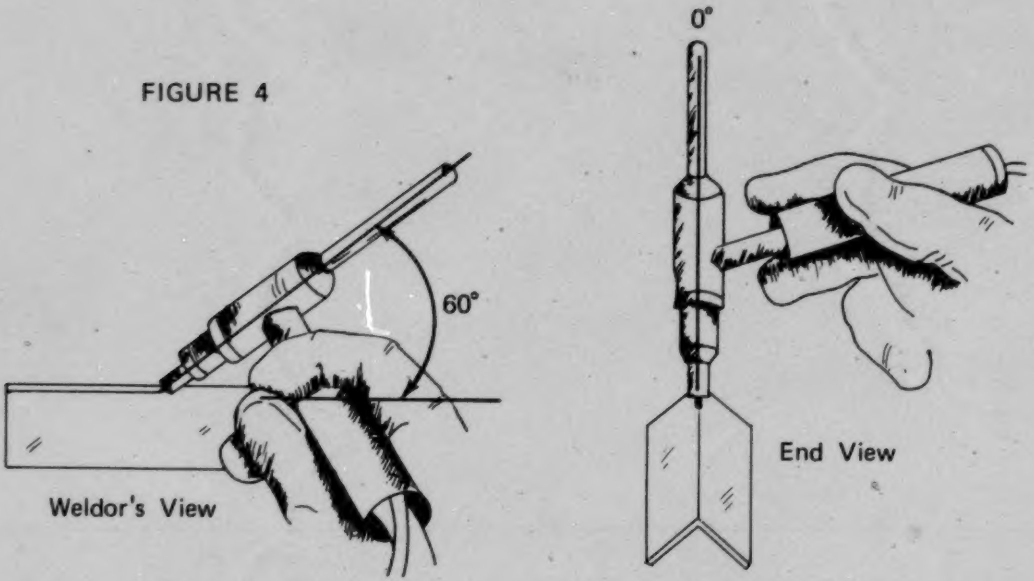
FIGURE 3



JOB SHEET #7

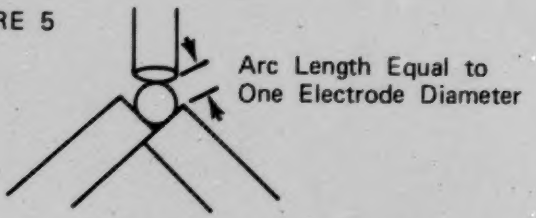
J. Position torch at 60° angle from table with no side angle (Figure 4)

FIGURE 4


0°
60°
Weldor's View
End View

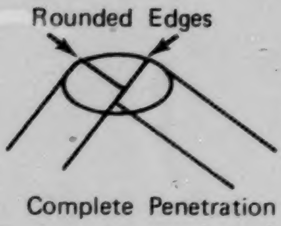
K. Start arc and maintain short arc length to flow metal into center of groove (Figure 5)

FIGURE 5


Arc Length Equal to
One Electrode Diameter

L. Weld at speed to round down joint edges and produce 100% penetration (Figure 6)

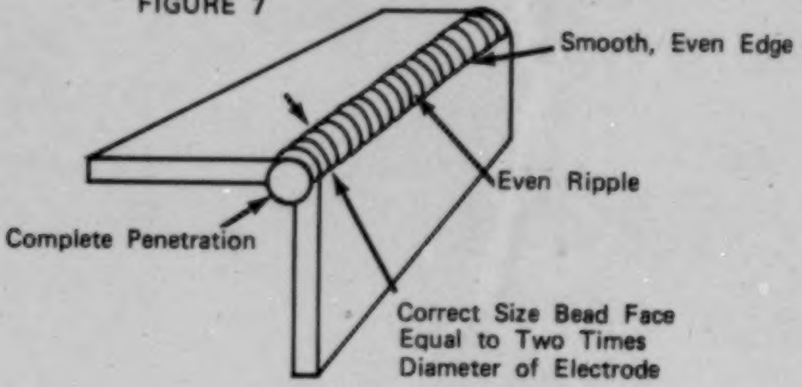
FIGURE 6


Rounded Edges
Complete Penetration

JOB SHEET #7

M. Inspect weld for smooth even edge and ripple, correct size bead, and complete penetration (Figure 7)

FIGURE 7


Smooth, Even Edge
Even Ripple
Complete Penetration
Correct Size Bead Face Equal to Two Times Diameter of Electrode

N. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #8-WELD A T-JOINT FILLET WELD ON ONE-EIGHTH INCH ALUMINUM WITH FILLER ROD IN THE HORIZONTAL POSITION

I. Equipment and materials

   A. GTAW power supply and required equipment

   B. Personal protective equipment

   C. Stainless steel wire brush (clean)

   D. Filler rod 1/8"

   E. Pure tungsten electrode 3/32" green strip (See chart 3.)

   (NOTE: Three-thirty-second inch electrode requires 3/32" collet and collet body.)

   F. Argon shielding gas 15-20 c.f.h.

   G. Two pieces, 1/8" x 2" x 6" aluminum

II. Procedure

   A. Clean aluminum with stainless wire brush to remove oxide coating

   B. Check torch for the following

      1. Nozzle (cup) size 3/8" inside diameter

         a. Unburnt

         b. Even end with no cracks or chips

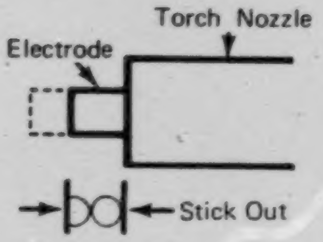
      2. Correct collet and collet body

      3. Correct tungsten with the following

         a. Round shiny end

         b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

JOB SHEET #8

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend tungsten 1/16-1/8" to aid weldor's view stick out of puddle and increase penetration.)

C. Attach ground clamp

D. Set welding machine and turn on power

1. AC current
2. Current adjustment
    a. Coarse adjustment--middle range 10-250
    b. Fine adjustment--maximum

E. Set high frequency

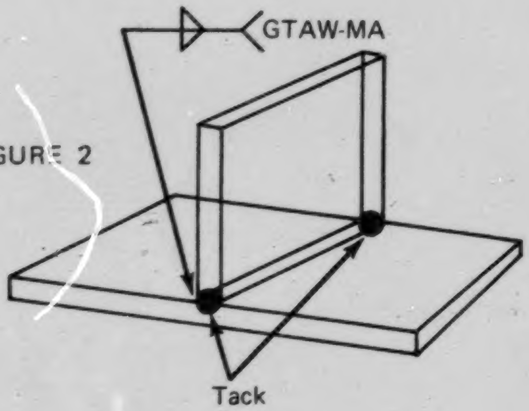
1. Continuous operation
2. Rheostat to medium

F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position two pieces of aluminum to form a T-joint (Figure 2)

FIGURE 2

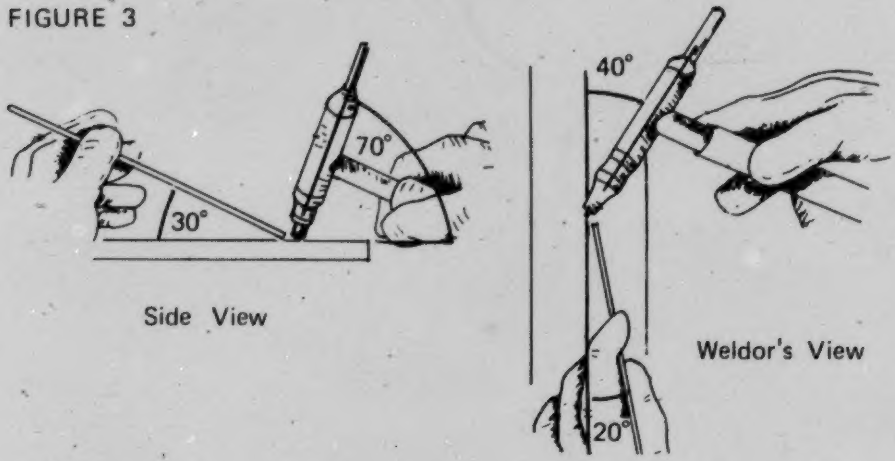


I. Tack each end of joint without filler rod (See Figure 2.)

JOB SHEET #8

J. Position torch at a 70° angle from table with a 40° side angle (Figure 3)

FIGURE 3



Side View

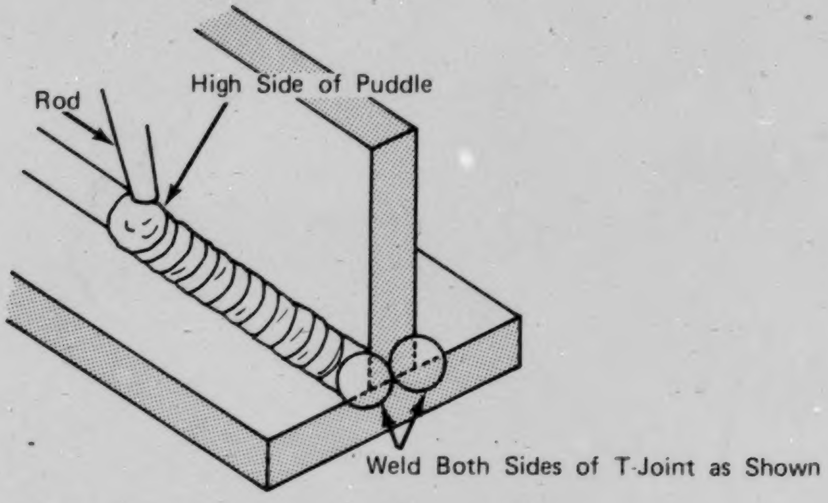
Weldor's View

K. Hold rod at 30° angle from table with a 20° side angle (See Figure 3.)

L. Start arc and form puddle at end of joint

M. Dip filler rod in and out at high side of leading edge of puddle to prevent undercutting (Figure 4)

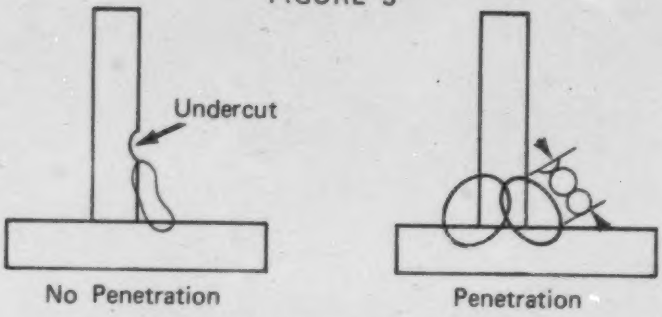
FIGURE 4


Rod
High Side of Puddle
Weld Both Sides of T-Joint as Shown

JOB SHEET #8

N. Travel at speed to produce a bead 2 1/2 to 3 times the diameter of electrode (Figure 5)

FIGURE 5



Bead Face Should Be 2 1/2 - 3 Times Diameter of Electrode

O. Hold close arc to insure deep penetration and to prevent undercutting (See Figure 5.)

P. Inspect weld for undercutting and smooth even ripple (See Figure 5.)

Q. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #9--CONSTRUCT A T-JOINT FILLET WELD ON ONE-EIGHTH INCH ALUMINUM WITH FILLER ROD IN THE VERTICAL UP POSITION

I. Equipment and materials

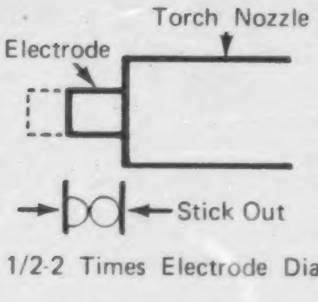
- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush (clean)
- D. 1/8" aluminum filler rod
- E. Pure tungsten electrode 3/32" green strip (See chart 3.)

  (NOTE: Three-thirty-second inch electrode requires a 3/32" collet and collet body.)
- F. Argon shielding gas 15-20 c.f.h.
- G. Two pieces, 1/8" x 2" x 6" aluminum

II. Procedure

- A. Clean aluminum with stainless wire brush to remove oxide coating
- B. Check torch for the following
  - 1. Nozzle (cup) size 3/8" inside diameter
    - a. Unburnt
    - b. Even end with no cracks or chips
  - 2. Correct collet and collet body (check)
  - 3. Correct tungsten with the following:
    - a. Round shiny end
    - b. Correct stick out (Figure 1)

FIGURE 1



1 1/2-2 Times Electrode Diameter

JOB SHEET #9

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16"-1/8" to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp

D. Set welding machine and turn on power

1. AC current

2. Current adjustment

a. Coarse adjustment--middle range 10-250

b. Fine adjustment--maximum

E. Set high frequency

1. Continuous operation

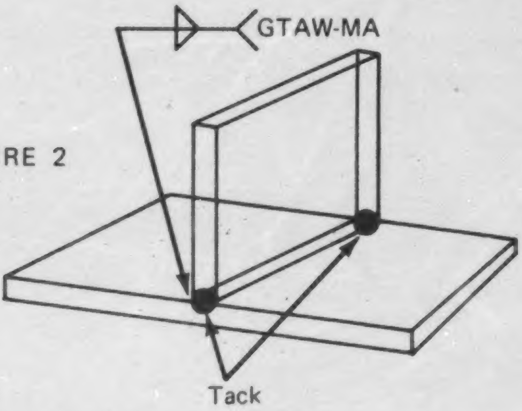
2. Rheostat to medium

F. Set shielding gas 15-20 c.f.h.

G. Set post purge to 15 seconds

H. Position two pieces of aluminum to form a T-joint (Figure 2)

FIGURE 2



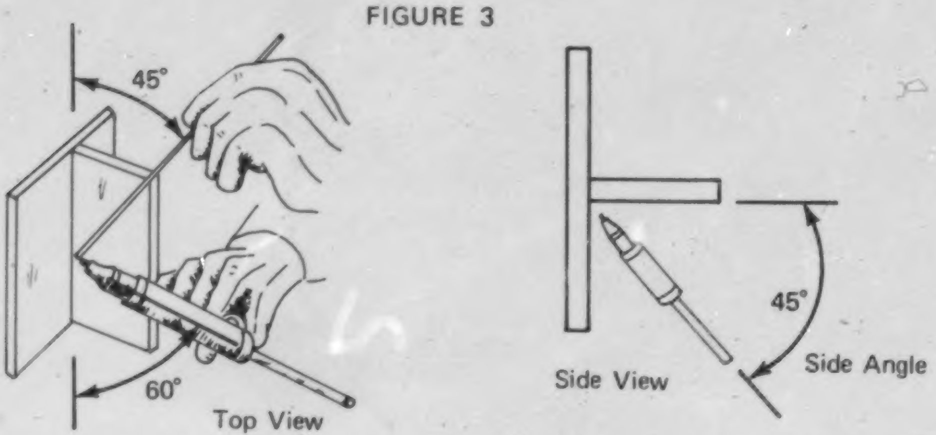
I. Tack each end of joint without filler rod (See Figure 2.)

J. Secure T-joint in vertical position

JOB SHEET #9

K. Center torch near bottom of joint holding a 45° side angle to each plate *with a 60° angle from work (Figure 3)*

FIGURE 3


45°
60°
Top View
Side View
45°
Side Angle

L. Hold rod at a 45° angle to each plate with a 45° angle to metal (See Figure 3.)

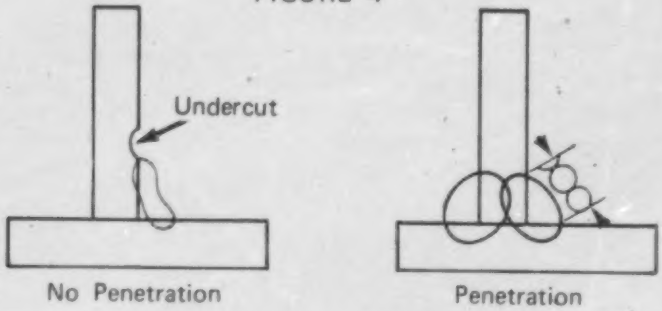
M. Start arc and rapidly form puddle at bottom of joint and center between plates

N. Dip filler rod in and out of leading edge of puddle being careful not to touch tungsten electrode

O. Bead should be 2 1/2 to 3 times diameter of tungsten

P. Hold close arc length to insure penetration to root of joint and to prevent undercut (Figure 4)

FIGURE 4


Undercut
No Penetration
Penetration

Bead Face Should Be 2 1/2 - 3
Times Diameter of Electrode

JOB SHEET #9

Q. Inspect weld for undercutting and smooth even ripple (See Figure 4.)

R. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #10--CONSTRUCT A BUTT JOINT ON ONE-SIXTEENTH INCH (16 ga) MILD STEEL WITH FILLER ROD IN THE FLAT POSITION

I. Equipment and materials

   A. GTAW power supply and required equipment

   B. Personal protective equipment

   C. Steel wire brush

   D. 1/16" mild steel filler rod

   E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)

   F. Argon shielding gas 10-12 c.f.h.

   G. 2 pieces of 1/16" x 2" x 6" mild steel sheet (cold roll) in clean condition

   H. Copper starting block--Machines without high frequency

II. Procedure

   A. Clean metal

   B. Check torch for the following

      1. Nozzle (cup) size--1/4" inside diameter

         a. Unburnt

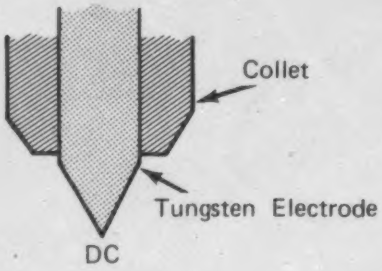
         b. Even end with no cracks or chips

      2. Correct collet and collet body (chuck)

      3. Prepared tungsten 1 to 2% thoriated

         a. Ground to a dull point (Figure 1)

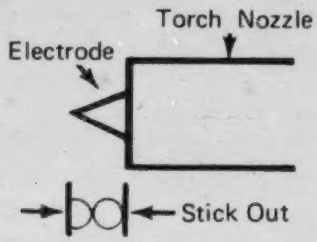
FIGURE 1



JOB SHEET #10

b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--90-140 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machine.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

F. Set shielding gas 10-12 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #10

H. Position two pieces of 1/16" mild steel to form a closed butt joint with no root gap and tack at each end (Figure 2)

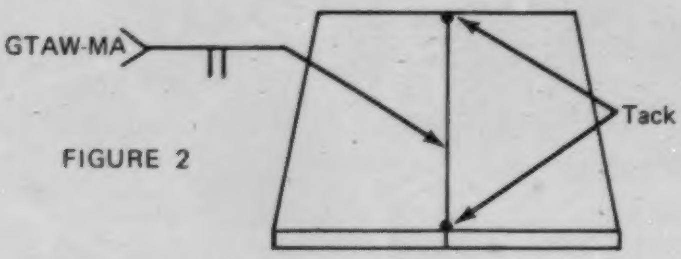
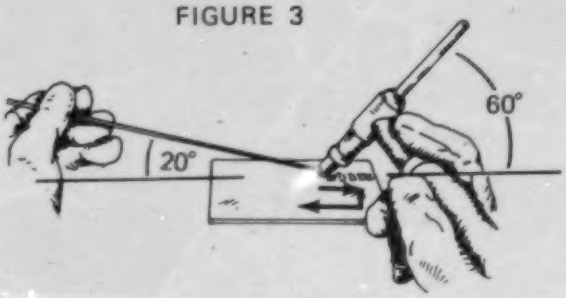


FIGURE 2

I. Position in the flat position

J Center torch between pieces at a 60° angle from table with no side angle (Figure 3)

FIGURE 3



Weldor's View

K. Hold rod at a 20° angle from table with no side angle (See Figure 3.)

L. Start arc and rapidly form puddle at end of joint

M. Dip rod into leading edge of puddle being careful not to touch the tungsten and to fill the crater at the end of the joint

JOB SHEET #10

N. Travel speed and rod manipulation should produce a bead 1 1/2 to 2 times the diameter of the tungsten

O. Inspect weld for smooth even ripples and contamination.

(NOTE: With DCSP, care must be exercised to prevent over penetration of the joint.)

P. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #11--CONSTRUCT A LAP JOINT FILLET WELD ON ONE-SIXTEENTH INCH MILD STEEL WITH FILLER ROD IN THE HORIZONTAL POSITION

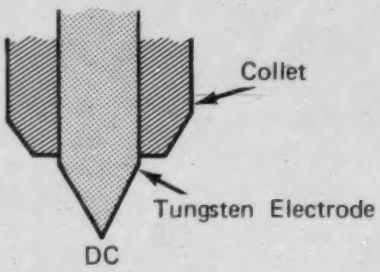
I. Equipment and materials

- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush
- D. 1/16" mild steel filler rod
- E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)
- F. Argon shielding gas 10-12 c.f.h.
- G. 2 pieces of 1/16" x 2" x 6" mild steel sheet (cold roll) in clean condition
- H. Copper starting block--Machines without high frequency

II. Procedure

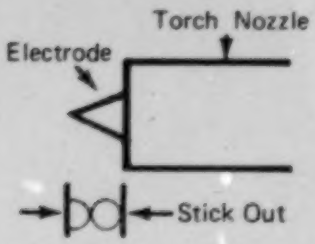
- A. Clean metal
- B. Check torch for the following
  - 1. Nozzle (cup) size--1/4" inside diameter
    - a. Unburnt
    - b. Even end with no cracks or chips
  - 2. Correct collet and collet body (chuck)
  - 3. Prepared tungsten 1 to 2% thoriated
    - a. Ground to a dull point (Figure 1)

FIGURE 1



b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--90-140 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machine.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

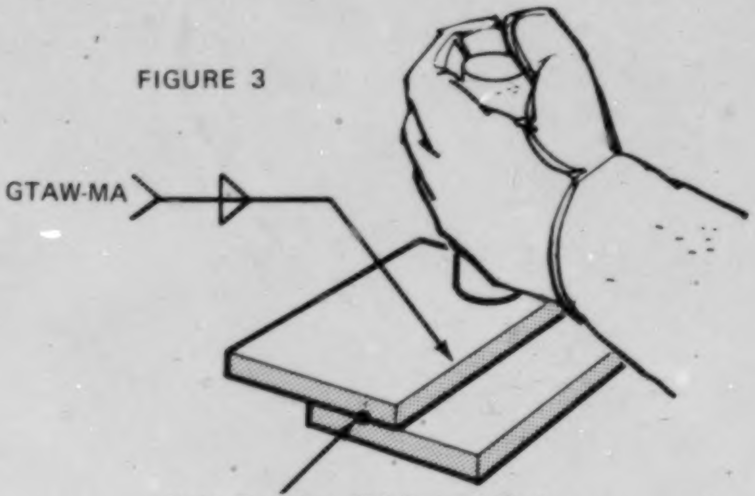
F. Set shielding gas 10 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #11

H. Position two pieces of 1/16" mild steel to form a lap joint and tack at each end (Figure 3)

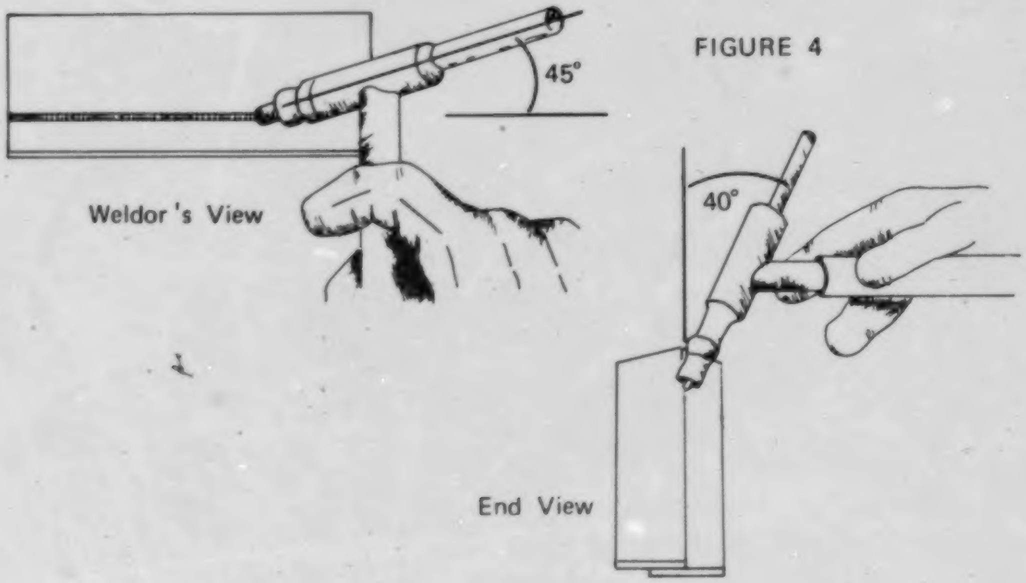
FIGURE 3



Hold Together Tightly and Tack

I. Place in horizontal position

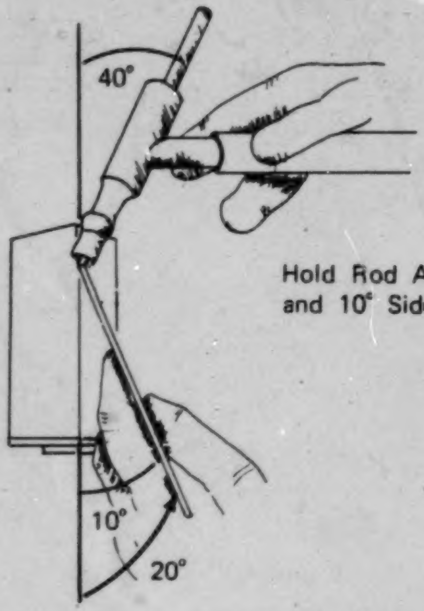
J. Position torch at a 45° angle from table with a 40° side angle toward you (Figure 4)


45°
Weldor 's View
FIGURE 4
40°
End View

JOB SHEET #11

K. Hold filler rod at a 20° angle from table with a 10° side angle toward you (Figure 5)

FIGURE 5

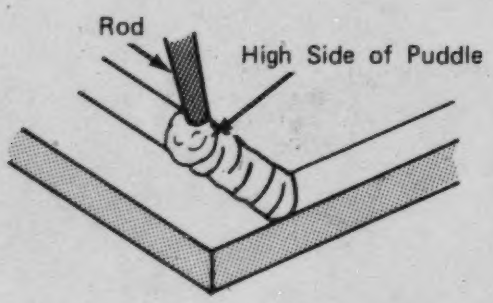


Hold Rod At 20° Angle from Table and 10° Side Angle (Toward You)

L. Start arc, then move torch to end of joint and form puddle

M. Dip filler rod in and out at high side of puddle to prevent undercutting (Figure 6)

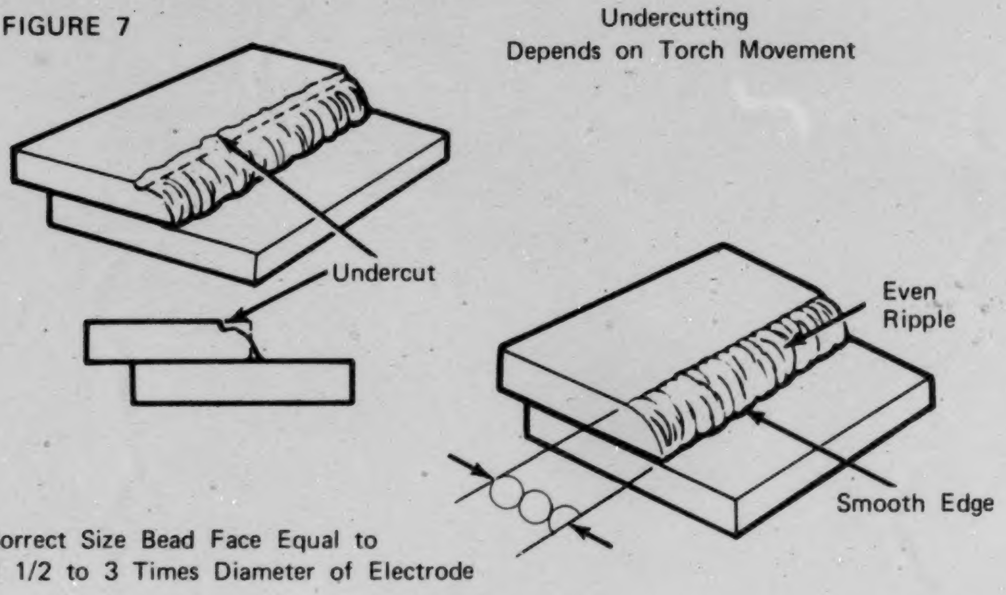
FIGURE 6



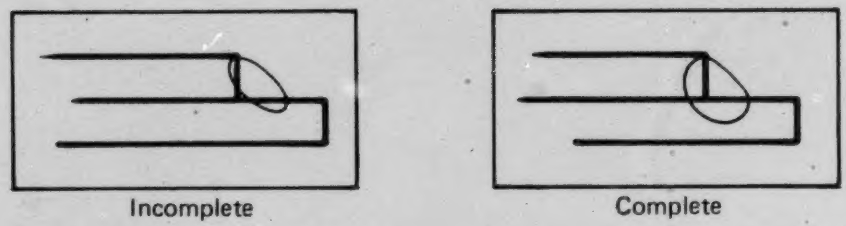
JOB SHEET #11

N. Inspect weld for undercutting and correct bead size with even ripples and complete penetration (Figure 7)

FIGURE 7


Undercutting
Depends on Torch Movement
Undercut
Even
Ripple
Smooth Edge
Correct Size Bead Face Equal to
2 1/2 to 3 Times Diameter of Electrode

Penetration


Incomplete

Complete

O. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #12--CONSTRUCT A T-JOINT FILLET WELD ON ONE-SIXTEENTH INCH MILD STEEL WITH FILLER ROD IN THE HORIZONTAL POSITION

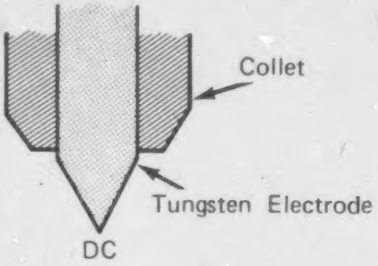
I. Equipment and materials

- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush
- D. 1/16" mild steel filler rod
- E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)
- F. Argon shielding gas 10 c.f.h.
- G. 2 pieces of 1/16" x 2" x 6" mild steel sheet (cold roll) in clean condition
- H. Copper starting block--Machines without high frequency

II. Procedure

- A. Clean metal
- B. Check torch for the following
    1. Nozzle (cup) size--1/4" inside diameter
        a. Unburnt
        b. Even end with no cracks or chips
    2. Correct collet and collet body (chuck)
    3. Prepared tungsten 1 to 2% thoriated
        a. Ground to a dull point (Figure 1)

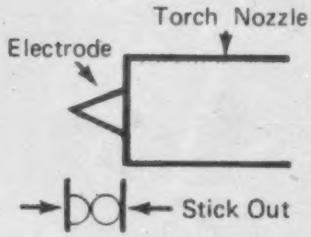
FIGURE 1



JOB SHEET #12

b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--90-140 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machine.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

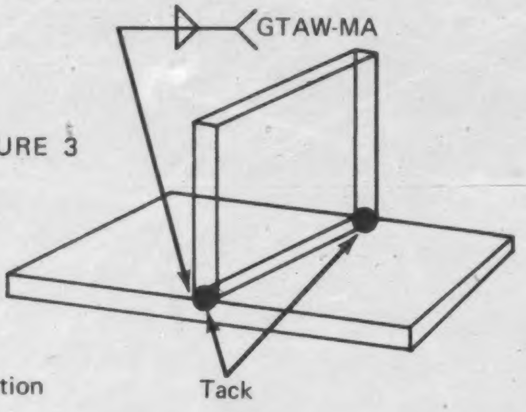
F. Set shielding gas 10 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #12

H. Position two pieces of 1/16" mild steel to form a T-joint and tack each end (Figure 3)

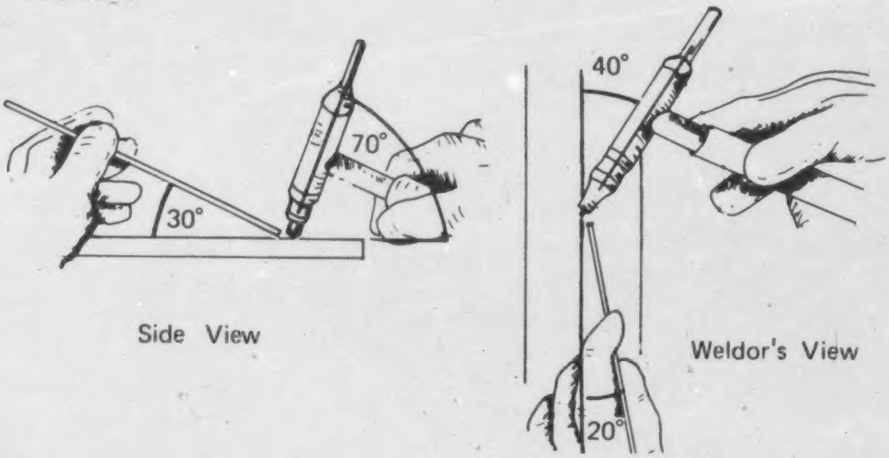
FIGURE 3



I. Place in horizontal position

J. Position torch at a 70° angle from table with a 40° side angle toward you (Figure 4)

FIGURE 4



Side View

Weldor's View

Hold filler rod at a 30° angle from table with a 20° side angle (See Figure 4.)

JOB SHEET #12

L. Start arc and form puddle at end of joint

M. Dip or lay filler rod in leading edge of puddle at high side to prevent undercutting (Figure 5)

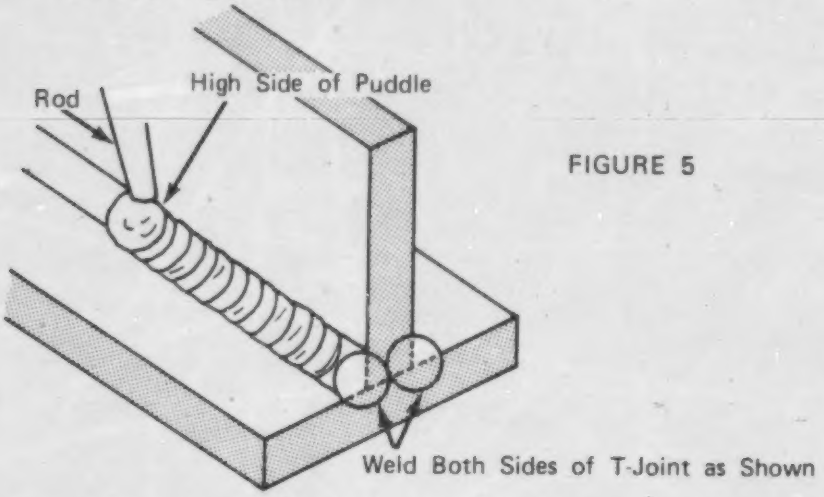
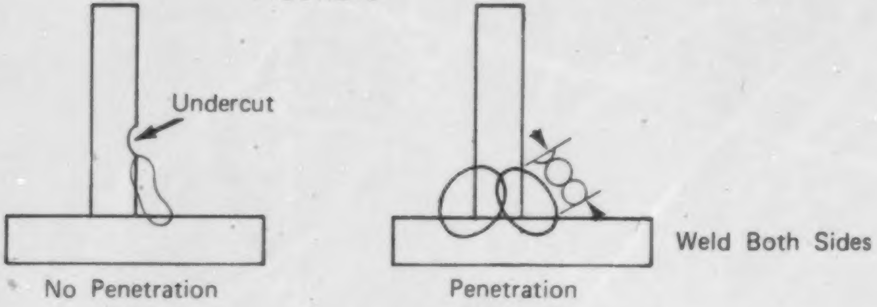

Rod
High Side of Puddle
Weld Both Sides of T-Joint as Shown

FIGURE 5

N. Travel at speed to produce a bead 2 1/2 to 3 times the diameter of the electrode (Figure 6)

FIGURE 6


Undercut
Weld Both Sides
No Penetration
Penetration

Bead Face Should Be 2 1/2 - 3
Times Diameter of Electrode

O. Hold close arc to insure deep penetration and to prevent undercut; weld both sides (See Figure 6.)

P. Inspect weld for smooth even ripple with no undercut (See Figure 6.)

Q. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #13--CONSTRUCT A BUTT JOINT ON ONE-SIXTEENTH INCH STAINLESS STEEL WITH FILLER ROD IN THE FLAT POSITION

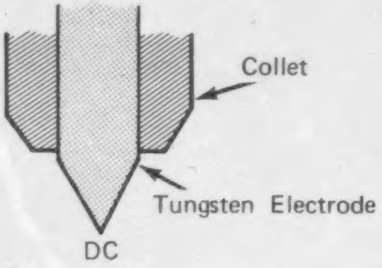
I. Equipment and materials

- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush (clean)
- D. 1/16" stainless steel filler rod
- E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)
- F. Argon shielding gas 12-15 c.f.h.
- G. 2 pieces of 1/16" x 2" x 6" stainless steel (clean condition)
- H. Copper starting block--Machines without high frequency

II. Procedure

- A. Clean metal
- B. Check torch for the following
  - 1. Nozzle (cup) size--1/4" inside diameter
    - a. Unburnt
    - b. Even end with no cracks or chips
  - 2. Correct collet and collet body (chuck)
  - 3. Prepared tungsten 1 to 2% thoriated
    - a. Ground to a dull point (Figure 1)

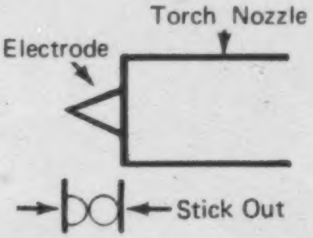
FIGURE 1



JOB SHEET #13

b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--60-100 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machines.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

F. Set shielding gas 12-15 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #13

H. Position two pieces of 1/16" stainless steel to form a closed butt joint with no root gap and tack at each end (Figure 3)

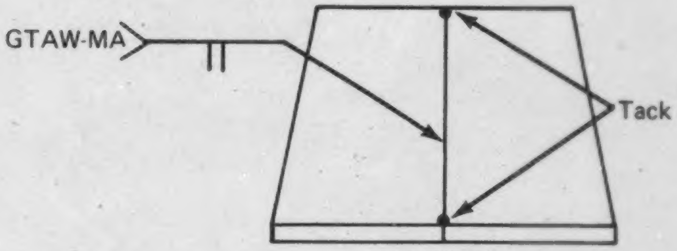
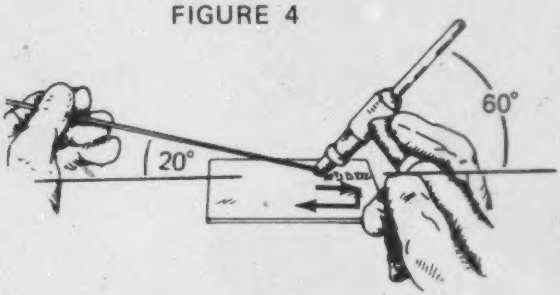


FIGURE 3

I. Position in the flat position

J. Center torch between pieces at a 60° angle from table with no side angle (Figure 4)

FIGURE 4



Weldor's View

K. Hold rod at 20° angle from table with no side angle (See Figure 4.)

L. Start arc and rapidly form puddle at end of joint holding a close arc length

M. Dip or lay filler rod into leading edge of puddle being careful to avoid touching tungsten and to fill the crater the end of joint

JOB SHEET #13

N. Travel speed plus rod and touch manipulation should produce a bead 1 1/2 to 2 times the diameter of the tungsten

(NOTE: When weld is complete, shut off current and hold torch in position at end of joint to allow post flow shielding gas to protect weld zone from surface oxidation until it loses its red color.)

(CAUTION: Care must be taken to avoid excessive heat in weld zone. Some type of copper back up bar or insert is helpful particularly when welding thinner sections.)

O. Inspect face of weld for smooth even ripple without excessive piling up or undercut

P. Inspect root of weld for distinct even heat lines without over penetration or excessive distortion

Q. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #14--CONSTRUCT AN OUTSIDE CORNER JOINT ON ONE-SIXTEENTH INCH STAINLESS STEEL WITHOUT FILLER ROD IN THE FLAT POSITION

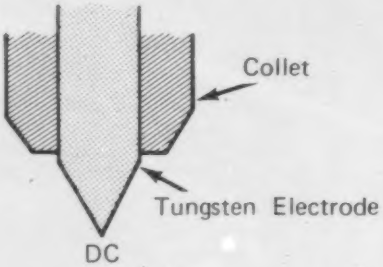
I. Equipment and materials

- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush (clean)
- D. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)
- E. Argon shielding gas 10-12 c.f.h.
- F. 2 pieces of 1/16" x 2" x 6" stainless steel sheet (clean condition)
- G. Copper starting block--Machines without high frequency

II. Procedure

- A. Clean metal
- B. Check torch for the following
  - 1. Nozzle (cup) size--1/4" inside diameter
    - a. Unburnt
    - b. Even end with no cracks or chips
  - 2. Correct collet and collet body (chuck)
  - 3. Prepared tungsten 1 to 2% thoriated
    - a. Ground to a dull point (Figure 1)

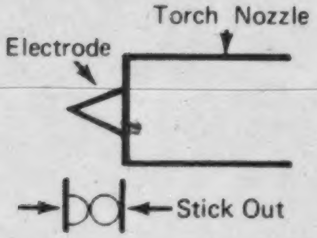
FIGURE 1



JOB SHEET #14

b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--70-140 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machine.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

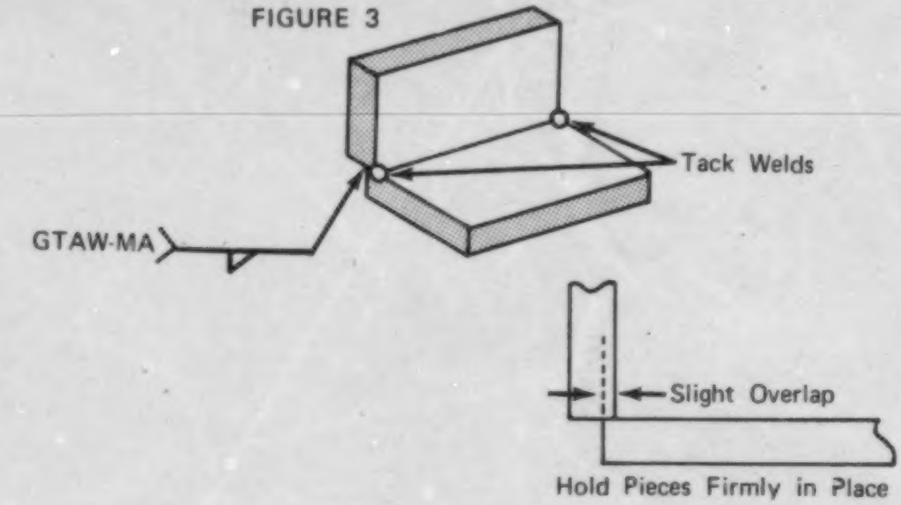
F. Set shielding gas 10-12 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #14

H. Position two pieces of 1/16" stainless to form a corner joint and tack weld (Figure 3)

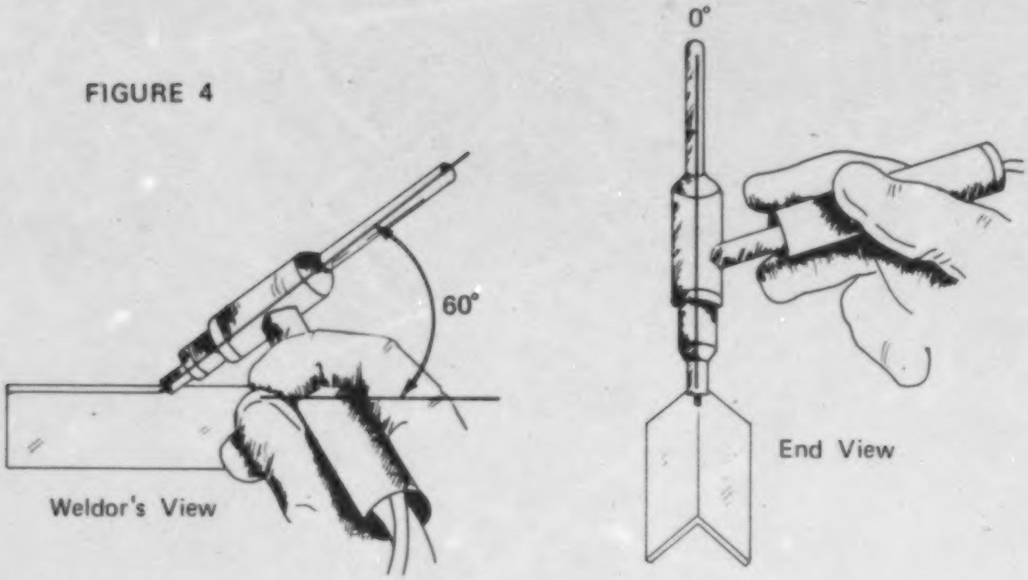
FIGURE 3


Tack Welds
GTAW-MA
Slight Overlap
Hold Pieces Firmly in Place

I. Position metal in flat position

J. Center torch at a 60° angle from table with no side angle (Figure 4)

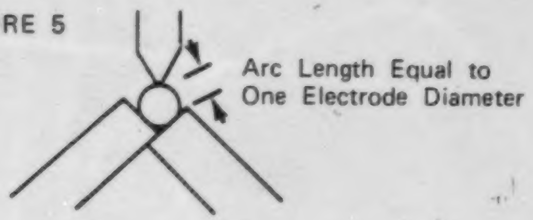
FIGURE 4


0°
60°
Weldor's View
End View

JOB SHEET #14

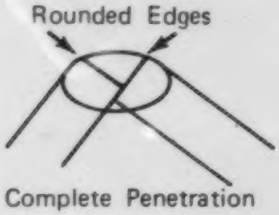
K. Start arc at end of joint holding a short arc length in the center of the groove (Figure 5)

FIGURE 5


Arc Length Equal to
One Electrode Diameter

L. Weld at a speed to round down workpiece edges and give complete penetration (Figure 6)

FIGURE 6

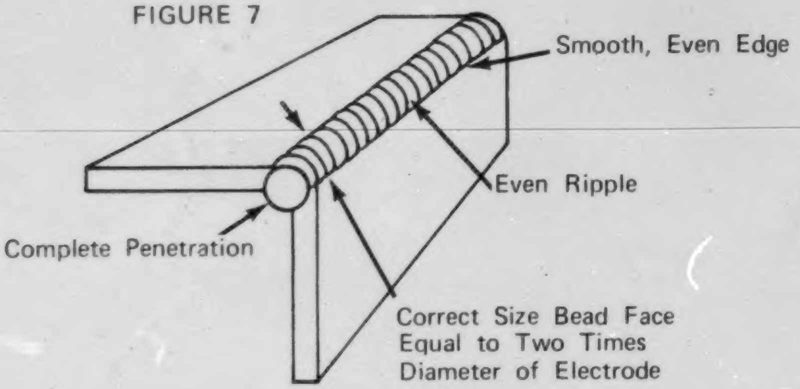

Rounded Edges
Complete Penetration

(NOTE: When weld is complete, shut off current and hold torch in position at end of joint to allow post flow shielding gas to protect weld zone from surface oxidation until it loses its red heat.)

JOB SHEET #14

M. Inspect weld for the following (Figure 7)

FIGURE 7


Smooth, Even Edge
Even Ripple
Complete Penetration
Correct Size Bead Face Equal to Two Times Diameter of Electrode

(NOTE: Weld bead should have a bright copper finish or natural stainless color.)

N. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #15--CONSTRUCT A T-JOINT FILLET WELD ON ONE-EIGHTH INCH STAINLESS STEEL WITH FILLER ROD IN THE HORIZONTAL POSITION

I. Equipment and materials

   A. GTAW power supply and required equipment

   B. Personal protective equipment

   C. Stainless steel wire brush (clean)

   D. 3/32" stainless steel filler rod

   E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)

   F. Argon shielding gas 12-15 c.f.h.

   G. 2 pieces of 1/16 x 2" x 6" stainless steel sheet (clean condition)

   H. Copper starting block--Machines without high frequency

II. Procedure

   A. Clean metal

   B. Check torch for the following

      1. Nozzle (cup) size--5/16" inside diameter

         a. Unburnt

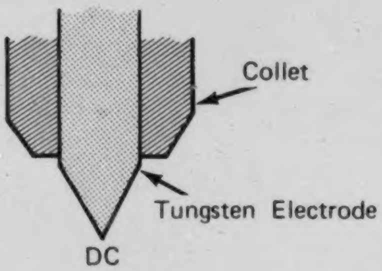
         b. Even end with no cracks or chips

      2. Correct collet and collet body (chuck)

      3. Prepared tungsten 1 to 2% thoriated

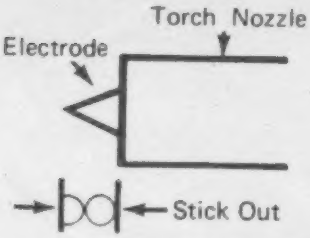
         a. Ground to a dull point (Figure 1)

FIGURE 1



b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--90-140 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machines.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

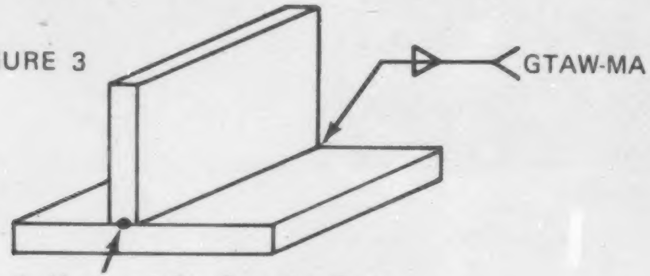
F. Set shielding gas 12-15 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #15

H. Position two pieces of 1/8" stainless steel to form a tight T-joint and tack weld (Figure 3)

FIGURE 3

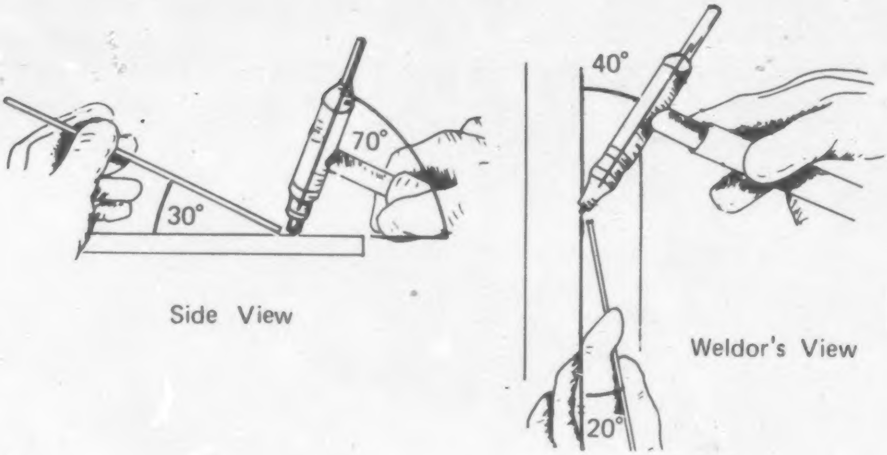


Tack Here and On Opposite End

I. Position metal in the horizontal position

J. Hold torch at a 70° angle from table with a 40° side angle toward you (Figure 4)

FIGURE 4



Side View

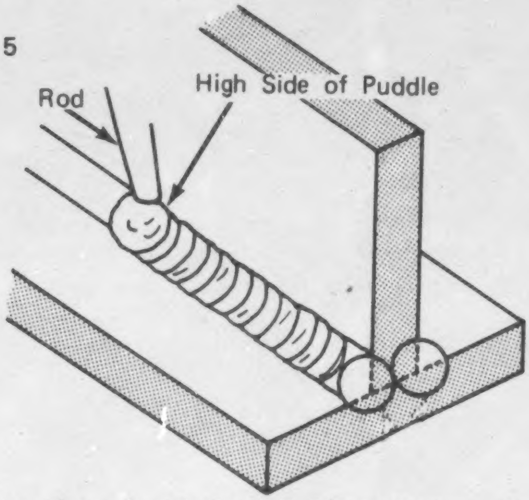
Weldor's View

K. Hold rod at a 30° angle from table with a 20° side angle toward you (See Figure 4.)

JOB SHEET #15

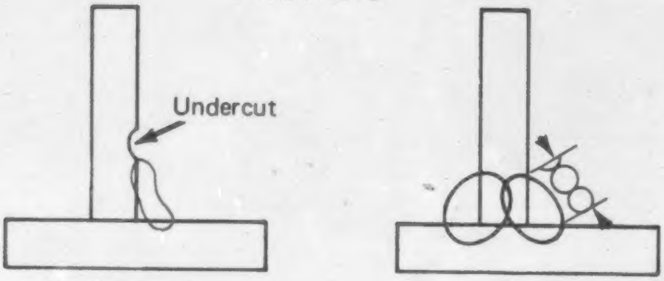
L. Start arc and form puddle dipping filler rod in and out at high side of leading edge of puddle to prevent undercut (Figure 5)

FIGURE 5


Rod
High Side of Puddle

M. Travel at speed to deposit bead 2 1/2 to 3 times diameter of electrode (Figure 6)

FIGURE 6



No Penetration

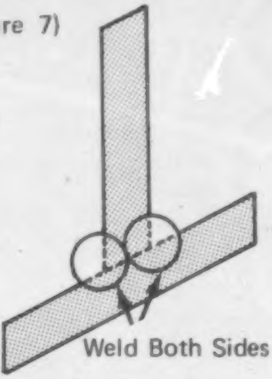
Penetration

JOB SHEET #15

N. Hold close arc length to insure deep penetration and to prevent undercut being careful to avoid touching electrode to base metal or filler rod

O. Weld both sides of joint (Figure 7)

FIGURE 7



Weld Both Sides of T-Joint as Shown

(NOTE: When weld is complete at the end of joint, shut off current and hold torch in position to allow post flow shielding gas to protect weld zone from surface oxidation until it loses its red color.)

P. Inspect weld for smooth even edge with no undercut, even ripple, correct bead size, and deep penetration

(NOTE: Weld bead should have a bright finish. A dark color indicates too much current, too long arc length, not enough shielding gas, excessive filler metal or contaminated tungsten.)

Q. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

JOB SHEET #16--CONSTRUCT A T-JOINT FILLET WELD ON ONE-EIGHTH INCH STAINLESS STEEL WITH FILLER ROD IN THE VERTICAL UP POSITION

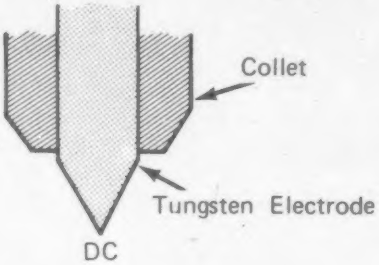
I. Equipment and materials

- A. GTAW power supply and required equipment
- B. Personal protective equipment
- C. Stainless steel wire brush
- D. 3/32" stainless steel filler rod
- E. 1 or 2% thoriated tungsten 1/16" (yellow or red strip) with 1/16" collet and collet body (chuck)
- F. Argon shielding gas 12-15 c.f.h.
- G. 2 pieces of 1/16" x 2" x 6" stainless steel sheet (clean condition)
- H. Copper starting block--Machines without high frequency

II. Procedure

- A. Clean metal
- B. Check torch for the following
  - 1. Nozzle (cup) size--5/16" inside diameter
    - a. Unburnt
    - b. Even end with no cracks or chips
  - 2. Correct collet and collet body (chuck)
  - 3. Prepared tungsten 1 to 2% thoriated
    - a. Ground to a dull point (Figure 1)

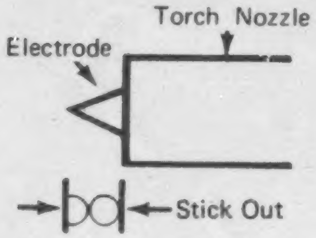
FIGURE 1



JOB SHEET #16

b. Correct stick out (Figure 2)

FIGURE 2



1 1/2-2 Times Electrode Diameter

c. Finger tighten cap to secure tungsten

(NOTE: It may be helpful to extend electrode 1/16" to 1/8" further to aid weldor's view of puddle and increase penetration.)

C. Attach ground clamp to workpiece

D. Set welding machine and turn on power

1. DCSP--80-130 amps

2. Current adjustment

a. Coarse--Middle range

b. Fine--Maximum with foot control

(NOTE: If machine is used without foot control, a specific current adjustment will be necessary as all current control will be manual at the machine.)

E. High frequency (if available on machine)

1. Start only

2. Rheostat to medium

(NOTE: For machines without high frequency, strike arc on a copper starting block to avoid tungsten contamination.)

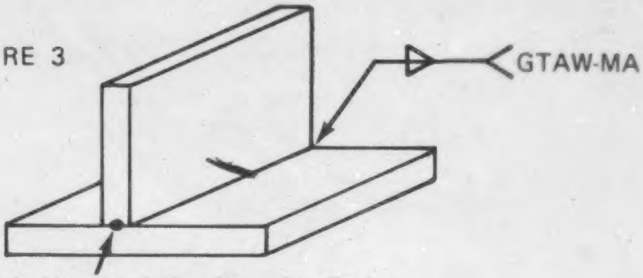
F. Set shielding gas to 12-15 c.f.h.

G. Set post purge (gas afterflow timer) to 15 seconds

JOB SHEET #16

H. Position two pieces of 1/8" stainless steel to form a tight T-joint and tack weld (Figure 3)

FIGURE 3

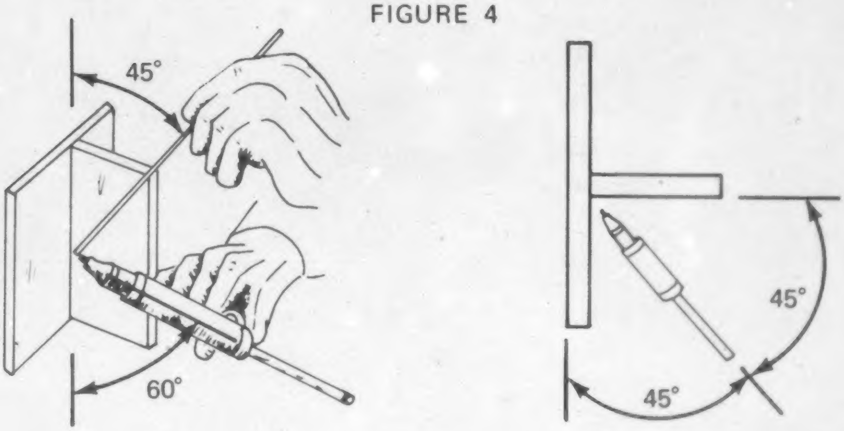


Tack Here and On Opposite End

I. Position metal in the vertical position

J. Center torch at bottom of joint holding a 45° side angle to each plate with a 60° angle from work (Figure 4)

FIGURE 4



Side View

Top View

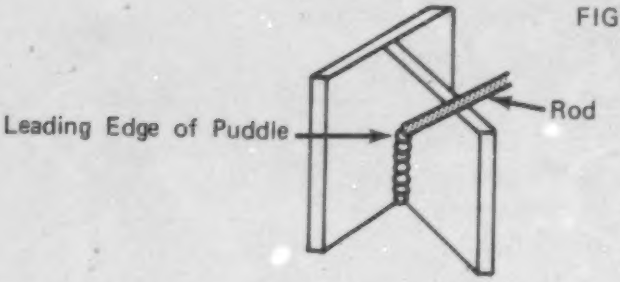
K. Hold filler rod at a 45° angle to each plate with a 45° angle to metal (See Figure 4.)

L. Start arc and form puddle at bottom of joint and centered between plates

JOB SHEET #16

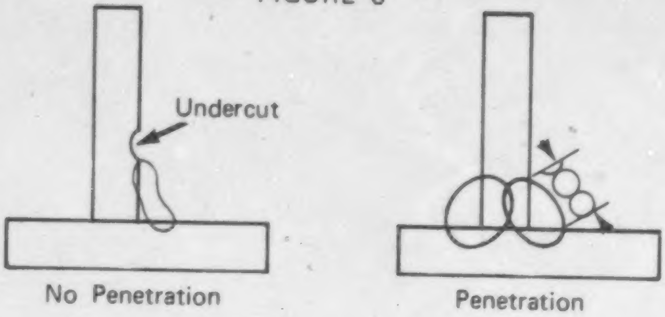
M. Dip or lay filler rod in leading edge of puddle being careful to avoid touching tungsten electrode to filler rod or work (Figure 5)

FIGURE 5



N. Hold close arc length to insure penetration to root of joint and to prevent undercut, weld head should be 2 1/2 to 3 times diameter of tungsten (Figure 6)

FIGURE 6

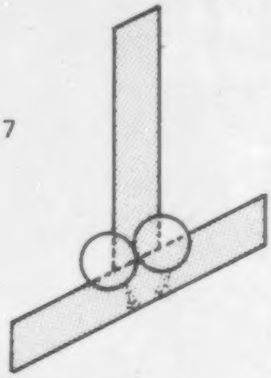


No Penetration

Penetration

O. Weld both sides of joint (Figure 7)

FIGURE 7



(NOTE: When weld is completed at end of joint, shut off current and hold torch in position to allow post flow shielding gas to protect weld zone from surface oxidation until it loses its red color.)

JOB SHEET #16

P. Inspect weld for smooth even edge with no undercut, even ripple, correct bead size, and deep penetration

(NOTE: Weld bead should have a bright finish. A dark finish indicates too much current, too long arc length, not enough shielding gas, excessive filler metal or contaminated tungsten.)

Q. Submit to instructor for inspection

GAS TUNGSTEN ARC WELDING
UNIT I

TEST

1. Match the following terms with the correct definition.

_____a. A device used by the welder to control welding current during the welding process

_____b. A thin film that forms on the surface of aluminum due to a reaction between the metal and oxygen in the air

_____c. A chucking device used to hold the tungsten in the torch

_____d. The science and technology of metals

_____e. An arc welding process wherein coalescence (fusion) is produced by heating with an arc between a non-consumable tungsten electrode and the base metal utilizing an inert gas, argon, or helium that shields the weld zone from contamination by oxygen and nitrogen in the air

_____f. A calibrated metering device used to regulate the flow of gases to the torch and measured in cubic feet per hour (c. f. h.)

_____g. A holding device for the collet

_____h. An attachment that fits on the end of the GTAW torch to direct the flow of shielding gas to the tungsten and weld zone

_____i. A gas which will not combine with other gases used to surround the weld zone and prevent contamination of the weld by oxygen and nitrogen in the air

1. Gas tungsten arc welding
2. Inert shielding gas
3. Tungsten electrode
4. High frequency current
5. Aluminum oxide
6. Gas cup
7. Collet body (chuck)
8. Flowmeter
9. Foot control
10. Collet
11. Thermal conductivity
12. Metallurgy
13. Porosity

_____j. The characteristic of a metal to conduct heat throughout its thickness, width, and length

_____k. Gas pockets or voids in metal

_____l. A high voltage low power source introduced into the A. C. weld current to start the arc and aid in oxide removal when welding aluminum

_____m. A practically non-consumable welding electrode used to create an intense arc between the tip of the electrode and the work

2. Name three applications of the GTAW process.

a.

b.

c.

3. Select five advantages of the GTAW process from the following examples. (Place an "X" by the correct example.)

_____a. Slag and spatter easily removed

_____b. Welder has very close control of welding current

_____c. Arc and weld puddle clearly visible to welder

_____d. Welding speeds are much faster than the GMAW process

_____e. Minimum of distortion and stress with heat concentrated in a small area

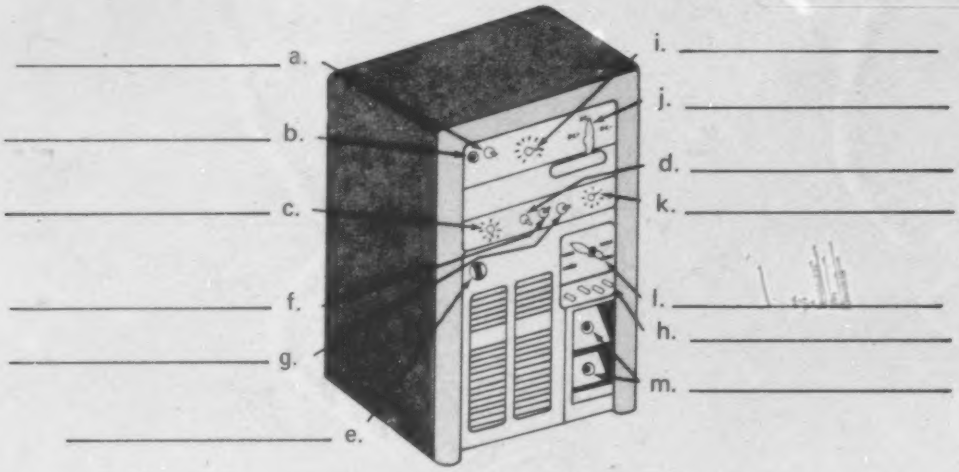
_____f. No flux used and no post cleaning required

_____g. Makes excellent root pass on carbon and stainless steel pipe

_____h. Used exclusively on heavy plates where rapid production is necessary

_____i. Lends itself to assembly line use in the auto industry

4. Identify the major controls of the GTAW power supply from the drawing below.

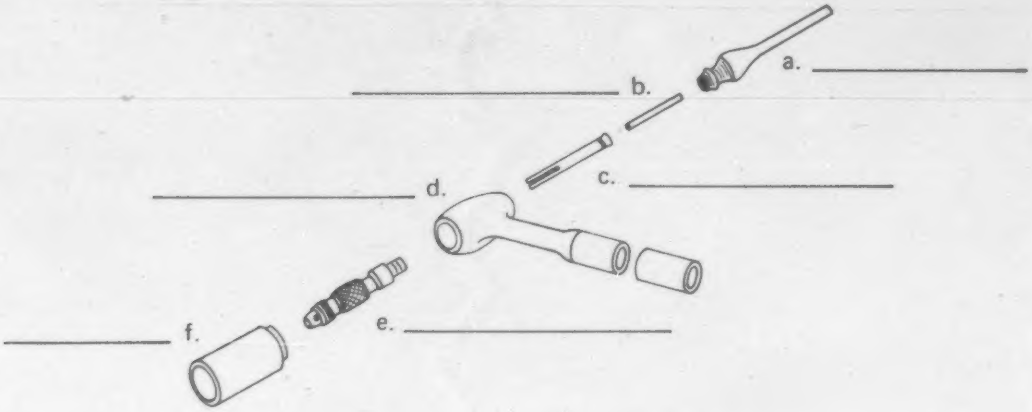


5. Name the two types of welding current used most in GTAW welding.

a.

b.

6. Identify the six major parts of a GTAW torch from the drawing below.



7. Name the three most commonly used gas cups for GTAW welding.

a.

b.

c.

8. Name the color, finish, type, and application when given the type of tungsten electrode.

Type of Electrode	Color	Finish	Sizes	Applications
a. Pure				
b. 1% Thoriated				
c. 2% Thoriated				
d. Zirconiated				

9. a. Aluminum

Match the following filler metals to the correct base metals

______1) Base metal 3003 a) 1100

______2) Base metal 5052 b) 5356

______3) Base metal 6061 c) 5652

______4) Base metal 5005 d) 4043

b. Stainless

______1) Base metal 347 a) 308

______2) Base metal 308 b) 316L

______3) Base metal 304 clad c) 310

______4) Base metal 316L d) 347

10. List the major metallurgical factors to be considered when welding the following.

Aluminum

a.

b.

c.

Stainless

a.

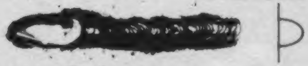
b.

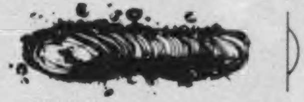
11. Match the illustrations of poor welds with the cause of each.

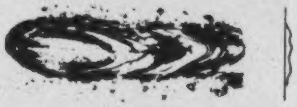
_____a. Welding speed too fast

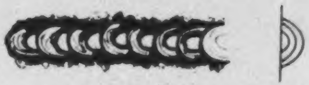
_____b. Welding current too high

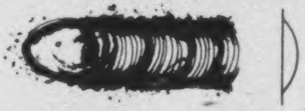
_____c. Welding speed too slow

1.


2.


3.


4.


5.


_____d. Arc too long (voltage too high)

_____e. Welding current too low

12. Name five characteristics of a good weld.

    a.

    b.

    c.

    d.

    e.

13. List the characteristics of argon and helium shielding gases.

    a. Argon

        1)

        2)

        3)

        4)

    b. Helium

        1)

        2)

        3)

        4)

14. Performance evaluation will be given from the job sheets.

    (NOTE: This is not a test question. If this has not been accomplished prior to the test, ask your instructor when the above activities should be completed.)

GAS TUNGSTEN ARC WELDING
UNIT I

ANSWERS TO TEST

1.
   - a. 9
   - b. 5
   - c. 10
   - d. 12
   - e. 1
   - f. 8
   - g. 7
   - h. 6
   - i. 2
   - j. 11
   - k. 13
   - l. 4
   - m. 3

2.
   - a. Makes top quality welds possible on most all metals and alloys used in industry
   - b. Welds possible in all positions through a wide range of metal thickness
   - c. Used particularly for aluminum and its alloys (even on very thin sections)

3.
   - b
   - c
   - e
   - f
   - g

4.
   - a. Remote control switch (foot control)
   - b. Remote control receptacle (foot control)
   - c. Gas afterflow timer (post purge 0-60 seconds)
   - d. Soft start

e. Power switch--On-off

f. Weld control switch--SMAW or GTAW welding

g. High frequency spark switch

  1) On-off

  2) Start only

  3) Continuous

h. Gas and water connections

i. Fine adjustment current control

j. Polarity switch, DCRP, AC, DCSP

k. High frequency spark intensity rheostat

l. Current range selector

m. Ground and electrode terminals

5. a. Alternating current (AC) with high frequency for aluminum and magnesium

b. Direct current straight polarity (DCSP) for mild and stainless steel

6. a. Cap

b. Electrode

c. Collet

d. Torch body

e. Collet holder (body)

f. Gas nozzle (cup)

7. a. Ceramic

b. Pyrex glass

c. Metal

8.

	Color	Finish	Size	Application
a.	Green	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Aluminum or magnesium
b.	Yellow	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Mild or stainless steel

c.	Red	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Mild or stainless steel
d.	Brown	Ground or chemically etched	1/16, 3/32, 1/8, 5/32, 3/16, 1/4	Aluminum or magnesium

9. a. Aluminum

   1) a)

   2) c)

   3) b)

   4) d)

   b. Stainless

   1) d)

   2) a)

   3) c)

   4) b)

10. a. Melting point--Aluminum melts at 1220°F but requires higher welding currents than other metals due to its high thermal conductivity

    b. Aluminum oxide--Forms on the surface of aluminum when exposed to oxygen in the air; this oxide requires a temperature of 3700°F to melt or break down

    c. Heat colors--Aluminum shows no heat colors as it approaches the melting point

    d. Proper mechanical support--Since some aluminum alloys melt at 900°F care must be taken to support all areas subjected to the extreme heat of welding to prevent collapse, warping, and distortion

    Stainless

    a. Thermal conductivity--Stainless steel dissipates heat from the weld zone 40% to 50% slower than mild steel

    b. Distortion--Heat expansion in the weld zone is so slow, weld metal warpage is a problem

11. a. 5

    b. 2

- c. 4
- d. 1
- e. 3

12.
- a. Smooth edge
- b. Correct bead size
- c. Even penetration
- d. Even ripple
- e. Clean bright weld

13.
- a. Argon--Most popular gas for GTAW
  - 1) Easily obtainable at low cost
  - 2) Better shielding at lower flow rates (c. f. h.) than helium
  - 3) Easier arc starting than helium
  - 4) Better cleaning action when welding aluminum with AC current
- b. Helium--Used when welding thicker plates
  - 1) Yields higher heat for comparable current than argon
  - 2) Arc length is more critical than argon
  - 3) Has higher welding speeds than argon
  - 4) Produces poor arc stability and cleaning action

14. Performance skills will be evaluated to the satisfaction of the instructor.

GAS METAL ARC WELDING
UNIT II

TERMINAL OBJECTIVE

After completion of this unit, the student should be able to match terms associated with gas metal arc welding to the correct definition. He should be able to name the advantages of the GMAW process and set up and shut down the GMAW equipment for the three major applications of the process. He should be able to identify power sources, welding wires, and shielding gases used in this process and be able to perform the jobs outlined in this unit. This knowledge will be evidenced through demonstration and by scoring eighty-five percent on the unit test.

SPECIFIC OBJECTIVES

After completion of this unit, the student should be able to:

1. Match terms associated with the GMAW process to the correct definition.
2. List six advantages of the GMAW process.
3. Identify the major parts of GMAW equipment.
4. Select from a list three applications of the GMAW process.
5. List factors to be considered when selecting a filler wire for the GMAW process.
6. Name the two types of GMAW mild steel welding wires.
7. Match the shielding gases to their use.
8. Identify common weld mistakes.
9. List the characteristics of a good weld.
10. Name the two types of power sources.
11. Describe the effects of electrode wire stick out on volts and amps.
12. Demonstrate the ability to:
    a. Set up and shut down the GMAW equipment for short arc, spray arc, and flux cored arc welding applications.
    b. Construct a multiple pass T-joint fillet weld on 3/16" mild steel in the horizontal position with short arc.
    c. Construct a lap joint fillet weld on 3/16" mild steel in the vertical down position with short arc.

d. Construct a square groove butt joint on 3/16" mild steel in the flat position with short arc.

e. Construct a square groove butt joint on 3/16" mild steel in the horizontal position with short arc.

f. Construct a multiple pass T-joint fillet weld on 1/4"-3/8" mild steel in the vertical up position with short arc.

g. Construct a corner joint fillet weld on 1/4" mild steel in the vertical up position with short arc for break test.

h. Construct a square groove butt weld on 3/16" mild steel in the vertical up position with short arc.

i. Construct a T-joint fillet weld on 1/4" mild steel in the overhead position with short arc for break test.

j. Construct a square groove butt weld on 3/16" mild steel in the overhead position with short arc.

k. Construct a T-joint fillet weld on 16 ga. mild steel in the horizontal position with short arc.

l. Construct a single V-groove butt joint on 3/8" mild steel in the horizontal position with short arc for test.

m. Construct a single V-groove butt joint on 3/8" mild steel in the vertical down position with short arc for test.

n. Construct a single V-groove butt joint on 3/8" mild steel in the vertical up position with short arc for test.

o. Construct a single V-groove butt joint on 3/8" mild steel in the overhead position with short arc for test.

p. Construct a multiple pass lap joint fillet weld on 1" mild steel in the horizontal position with spray arc.

q. Construct a multiple pass V-joint fillet weld on 1" mild steel in the flat position with flux cored wire.

r. Construct a T-joint fillet weld on 1/4" aluminum plate in the horizontal position with short arc.

s. Construct a multiple pass T-joint fillet weld on 1/4" aluminum plate in the vertical up position with short arc.

t. Construct a T-joint fillet weld on 1/8" stainless steel in the horizontal position with short arc.

u. Construct a square groove butt weld on 1/8" stainless steel in the flat position with short arc.

GAS METAL ARC WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Instructor:

  A. Provide student with objective sheet.

  B. Provide student with information and job sheets.

  C. Discuss terminal and specific objectives.

  D. Discuss information sheet.

  E. Demonstrate and discuss procedures outlined in the job sheets.

  F. Give test.

II. Students:

  A. Read objective sheet.

  B. Study information sheet.

  C. Demonstrate the ability to accomplish the procedures outlined in the job sheets.

  D. Take test

INSTRUCTIONAL MATERIALS

I. Included in this unit:

  A. Objectives

  B. Information sheet

  C. Transparency masters

    1. TM 1--GMAW Equipment

    2. TM 2--GMAW Process

    3. TM 3--Weld Quality Inspection--Common Welding Mistakes

    4. TM 4--Weld Quality Inspection--Good Welds

    5. TM 5--GMAW Electric Wire Stick Out

    6. TM 6--Arc Length/Arc Volt-Amp Characteristics

D. Job sheets

1. Job Sheet #1--Set Up and Shut Down GMAW Equipment
2. Job Sheet #2--Construct a Multiple Pass T-Joint Fillet Weld in the Horizontal Position
3. Job Sheet #3--Construct a Lap Joint Fillet Weld in the Vertical Down Position
4. Job Sheet #4--Construct a Square Groove Butt Joint in the Flat Position With Short Arc
5. Job Sheet #5--Construct a Square Groove Butt Joint in the Horizontal Position With Short Arc
6. Job Sheet #6--Construct a Multiple Pass T-Joint Fillet Weld in the Vertical Up Position With Short Arc for Break Test
7. Job Sheet #7--Construct a Corner Joint Fillet Weld in the Vertical Up Position With Short Arc for Break Test
8. Job Sheet #8--Construct a Square Groove Butt Weld in the Vertical Up Position With Short Arc
9. Job Sheet #9--Construct a T-Joint Fillet Weld in the Overhead Position With Short Arc for Break Test
10. Job Sheet #10--Construct a Square Groove Butt Weld in the Overhead Position With Short Arc
11. Job Sheet #11--Construct a T-Joint Fillet Weld in the Horizontal Position With Short Arc
12. Job Sheet #12--Construct a Single V-Groove Butt Joint in the Horizontal Position With Short Arc for Test
13. Job Sheet #13--Construct a Single V-Groove Butt Joint in the Vertical Down Position With Short Arc for Test
14. Job Sheet #14--Construct a Single V-Groove Butt Joint in the Vertical Up Position With Short Arc for Test
15. Job Sheet #15--Construct a Single V-Groove Butt Joint in the Overhead Position With Short Arc for Test
16. Job Sheet #16--Construct a Multiple Pass Lap Joint Fillet Weld in the Horizontal Position With Spray Arc
17. Job Sheet #17--Construct a Multiple Pass V-Joint Fillet Weld in the Flat Position With Flux Cored Wire

18. Job Sheet #18--Construct a T-Joint Fillet Weld on Aluminum Plate in the Horizontal Position With Short Arc

19. Job Sheet #19--Construct a Multiple Pass T-Joint Fillet Weld on Aluminum Plate in the Vertical Up Position With Short Arc

20. Job Sheet #20--Construct a T-Joint Fillet Weld on Stainless Steel in the Horizontal Position With Short Arc

21. Job Sheet #21--Construct a Square Groove Butt Weld on Stainless Steel in the Flat Position With Short Arc

E. Test

F. Answers to test

II. References:

A. *American Welding Society Specifications on GMAW Wire Number A 5.18 and A 5.20.* American Welding Society, 2501 N. 7th Street, Miami, Florida.

B. Ahella, F.J. and R.P. Sullivan. *Gas Metal-Arc Welding of Stainless Steel Using Short-Circuiting Transfer.* Newark, New Jersey: Linde Division, Union Carbide Corp.

C. *Hobart Welding School Workbook.* Hobart School of Welding Technology. Troy, Ohio.

D. *How To Do Manual Metal Inert Gas Welding.* Newark, New Jersey: Linde Division, Union Carbide Corp.

E. Jefferson, T.B. and Gorham Woods. *Metals and How to Weld Them.* Cleveland, Ohio: James F. Lincoln Arc Welding Foundation.

F. *The Welding Encyclopedia.* Morton Grove, Illinois: Welding Engineer Publishing Company, Monticello Books.

G. *Stainless Steel--What It Is and How To Weld It.* Whittier, California: Stoody Company.

H. *Welding Alcoa Aluminum.* Pittsburgh, Pennsylvania: Aluminum Company of America.

I. *MIG Welding Aluminum.* Richmond, Virginia: Reynolds Aluminum Company.

J. *Welding Handbook.* Sixth Edition. Miami, Florida: American Welding Society.

K. *Fusion Welding Aluminum.* Richmond, Virginia: Reynolds Aluminum Company.

L. *Micro-Wire Welding.* Troy, Ohio: Hobart Brothers Technical Center.

M. *Hobart Welding Guide and Welding Lessons.* Troy, Ohio: Hobart Welding School.

N. *Fabco Welding.* Troy, Ohio: Hobart Brothers Technical Center.

GAS METAL ARC WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

A. Gas metal arc welding (GMAW)--An arc welding process in which a consumable base electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere (Transparencies 1 and 2)

(NOTE: Gas metal arc welding is sometimes called MIG welding.)

B. FCAW--Abbreviation for flux cored arc welding; a form of GMAW performed with a cored consumable electrode (flux inside the wire)

C. Short circuiting transfer (short arc)--A welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metal in all positions

D. Spray transfer (spray arc)--A welding process performed in GMAW usually done on thicker metal using larger diameter wires and a shielding gas mixture of argon with 1-5% oxygen done in the flat and horizontal positions only

E. Welding current (amperage)--Will usually be direct current reverse polarity (DCRP) with the welding wire positive (+) and the work negative (-)

F. Welding voltage (arc length)--The heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

G. Slope--The slant of the volts versus amps curve, generally referred to as volts change per 100 amps

H. Slope control--A control on the power supply that regulates the amount of pinch force available on welding wire, thereby controlling spatter or the pinch effect

I. Inductance--Controls the rate of rise of current without controlling the final amount of current available

(NOTE: In short arc welding, the inductance control will increase or decrease the number of short circuit metal transfers per second, from 20-200 times per second with an average of 100 times per second, increasing or decreasing the arc on time, thereby making the weld puddle more or less fluid.)

J. Stick out--The distance from the contact tip of the gun to the end of the electrode

INFORMATION SHEET

K. Whiskers--Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

L. Open circuit voltage--Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

M. Arc voltage--Voltage indicated by a volt meter on GMAW power supply when machine is welding

N. Ferrous--Any metal containing iron such as mild steel or stainless steel

O. Non-ferrous--Any metal that contains no iron such as aluminum or magnesium

P. Shielding gases--Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen from the atmosphere

II. Advantages of the GMAW process

A. Arc always visible to the welder

B. No slag and a minimum amount of spatter

C. High disposition rate with 95% of the welding wire deposited in the joint

D. Weld metal deposit of low hydrogen quality

E. Wide range of metal thicknesses can be welded without changing wire

F. Excellent for bridging gaps or misaligned joints without burn-through

G. Greatly reduced distortion in gage metal

H. Adaptable to weld most any metal by the selection of correct filler wire and shielding gases

I. Adaptable to either automatic or semi-automatic

III. Major parts of GMAW equipment (Transparency 1)

A. Power supply

B. Voltage control

C. Welding terminals

D. Power on-off switch

INFORMATION SHEET

E. Volt meter

F. Amp meter

G. Wire feed control system

H. Feed rolls

I. Wire feed control (amperage)

J. Wire reel or coil

K. Gun

L. Shielding gas

M. Flowmeter

IV. Applications of GMAW process

A. Short circuiting (short arc)--Employs low currents, low voltage, and small diameter wires

(NOTE: The short arc process is the most popular of the GMAW processes.)

B. Spray arc--Uses high current, high voltage, and large diameter wires for application on thicker metals

C. Flux cored wire--Designed primarily for welding steel

(NOTE: Some self-shielded (gasless) flux cored and solid wire applications utilize DCSP rather than DCRP.)

V. Factors to consider in selecting filler wire

A. Metal to be welded

B. Metal thickness and joint design

C. Metal surface condition

D. Specifications of the job

VI. Welding wires

A. Solid

(NOTE: Standard sizes of solid wire are: .035", .045", 1/16", 5/64", 3/32", and 1/8".)

INFORMATION SHEET

B. Flux cored

(NOTE: Standard wire sizes are: 1/16", 5/64", 3/32", 7/64", 1/8", and 5/32".)

VII. Shielding gases and their uses

A. Argon--Used to weld aluminum and magnesium

B. Argon-Helium--Used to weld heavy sections of aluminum

C. Argon-Co_2--Used to weld mild and stainless steel

(NOTE: One of the more popular mixtures for short arc is 75% Argon and 25% Co_2. This mixture is known as C-25.)

D. Helium--Argon--Co_2--Used for mild and stainless steels

(NOTE: Another one of the more popular mixes used in short arc welding contains 90% Helium, 7.5% Argon, and 2.5% Co_2.)

E. Co_2--Used for mild steel with short arc and flux cored application

F. Argon-Oxygen--Used for mild, stainless, and alloy steels and copper alloys

(NOTE: The nature of shielding gases require that GMAW be done where there is no excessive wind or drafts to displace the gas that results in brittle, porous welds.)

VIII. Common weld mistakes (Transparency 3)

A. Cold lapping (incomplete fusion)

B. Excessive penetration

C. Insufficient penetration

D. Burn through

E. Surface porosity

F. Poor appearance

G. Whiskers

H. Bad tie-in

I. Suck back (Internal concavity)

INFORMATION SHEET

IX. Characteristics of a good weld (Transparency 4)

- A. Even ripple on bead
- B. Slight crown (convex) at root
- C. Well fused throughout joint

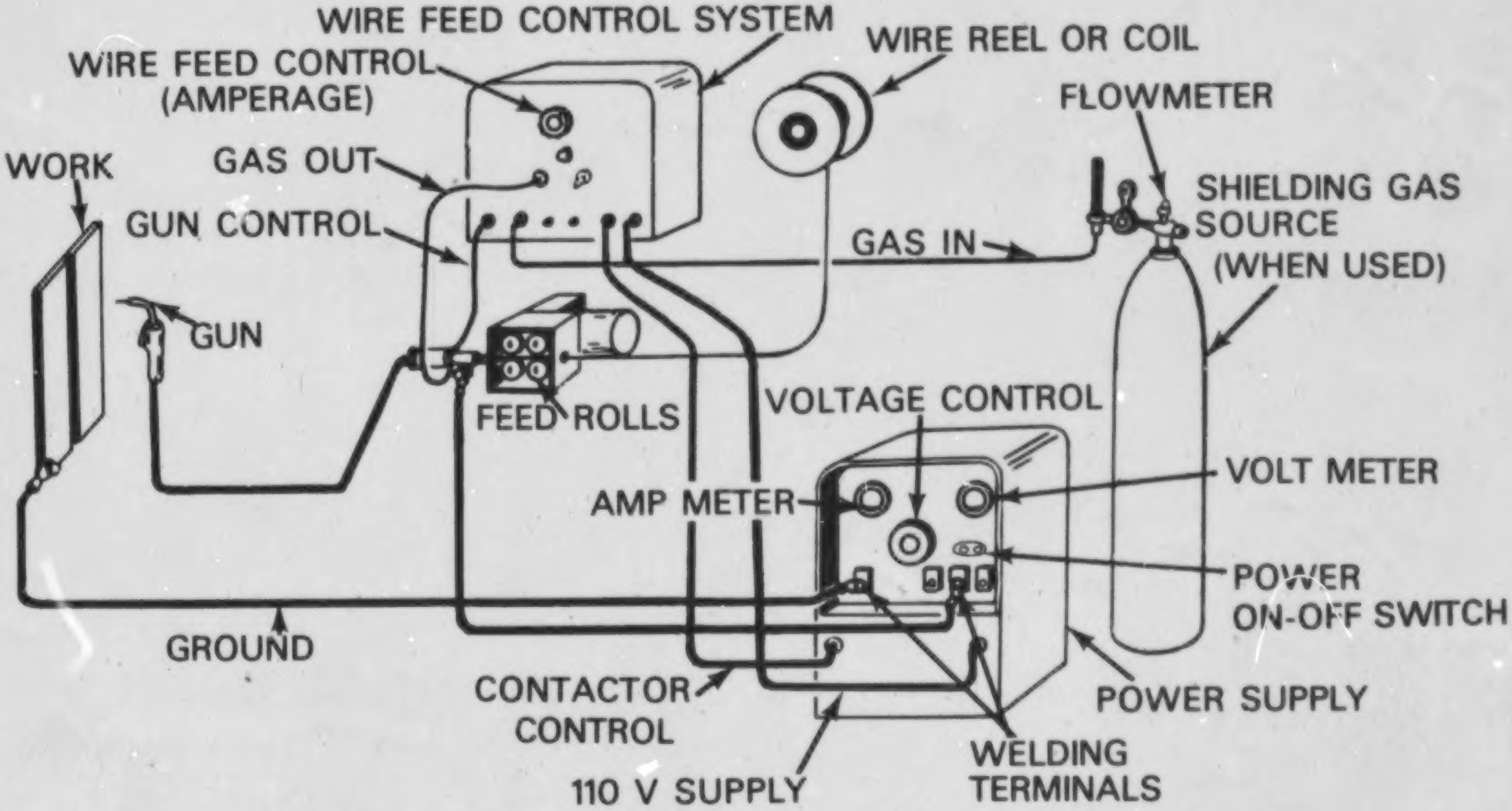
X. Types of power sources

- A. Transformer-rectifier
- B. Engine or motor generator

XI. Effects of electrode wire stick out on volts and amps (Transparencies 5 and 6)

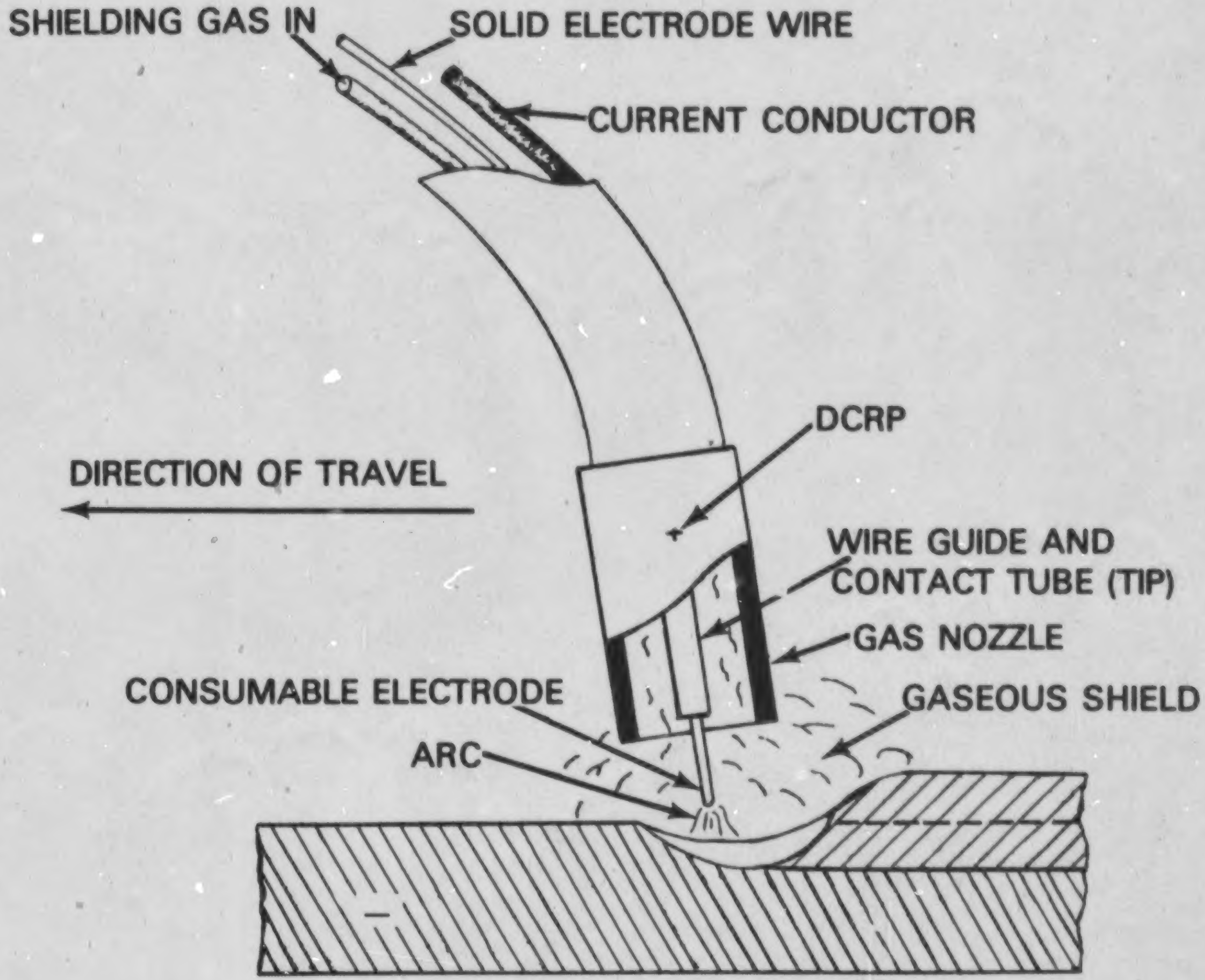
- A. Increased stick out (long arc)--Increases arc volts and decreases amps
- B. Short stick out (short arc)--Increases amps and decreases arc volts

GMAW Equipment

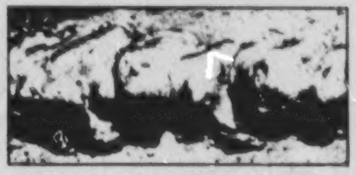

WIRE FEED CONTROL SYSTEM
WIRE REEL OR COIL
WIRE FEED CONTROL (AMPERAGE)
FLOWMETER
WORK
GAS OUT
SHIELDING GAS SOURCE (WHEN USED)
GUN CONTROL
GAS IN
GUN
FEED ROLLS
VOLTAGE CONTROL
VOLT METER
AMP METER
POWER ON-OFF SWITCH
GROUND
CONTACTOR CONTROL
POWER SUPPLY
WELDING TERMINALS
110 V SUPPLY

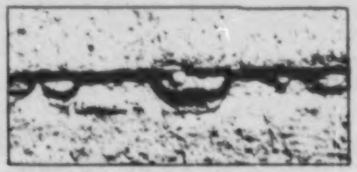
*DCRP- MOST GTAW APPLICATIONS
(NOTE: SOME FLUXCORED GTAW IS DONE WITH DCSP)

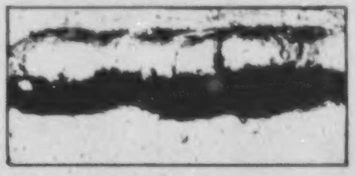
GMAW Process

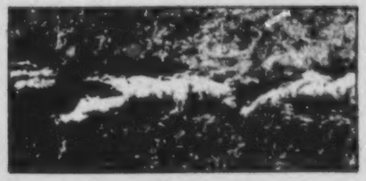

SHIELDING GAS IN
SOLID ELECTRODE WIRE
CURRENT CONDUCTOR
DCRP
DIRECTION OF TRAVEL
WIRE GUIDE AND CONTACT TUBE (TIP)
GAS NOZZLE
CONSUMABLE ELECTRODE
GASEOUS SHIELD
ARC

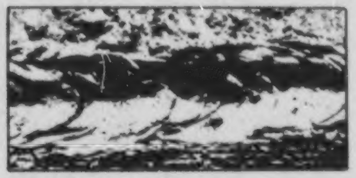
Weld Quality Inspection--Common Welding Mistakes

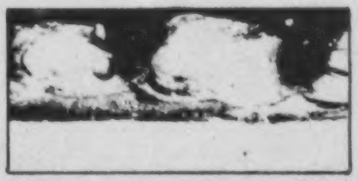

POOR APPEARANCE

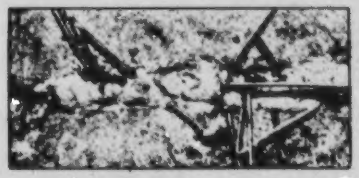

INSUFFICIENT PENETRATION

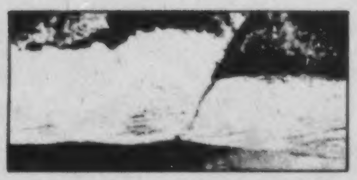

EXCESSIVE PENETRATION

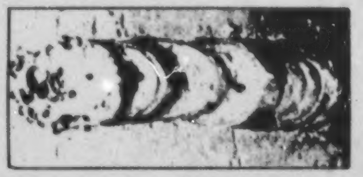

BAD TIE-IN


SUCK-BACK

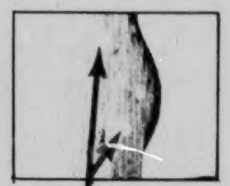

BURN-THROUGH


WHISKERS

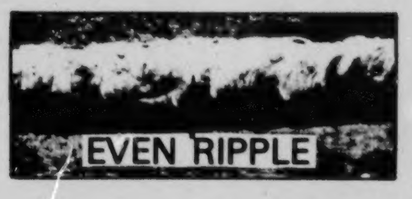

COLD LAPPING


SURFACE POROSITY

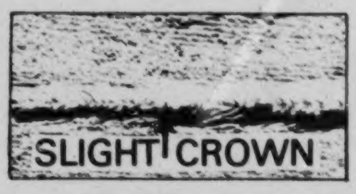
Weld Quality Inspection--Good Welds



END

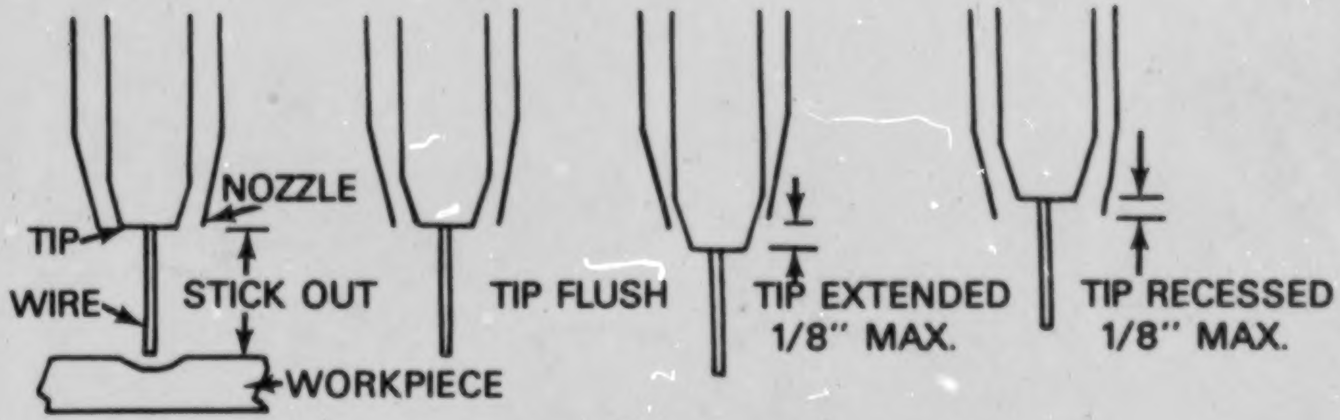

EVEN RIPPLE

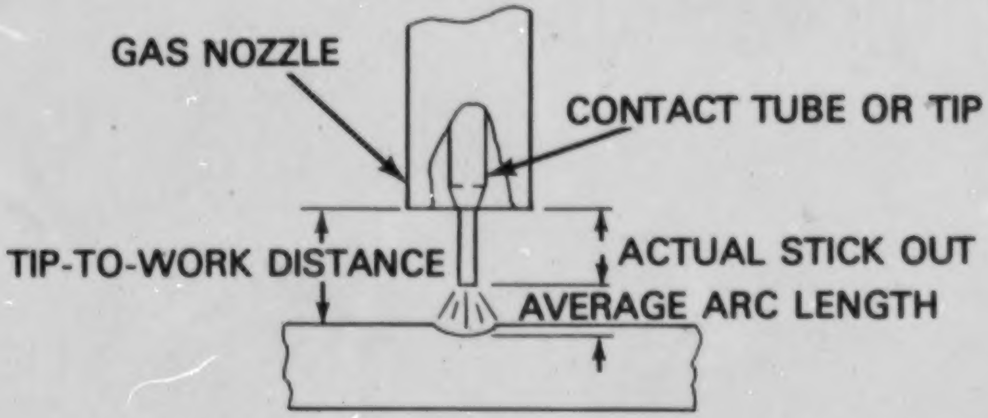
TOP


SLIGHT CROWN

BOTTOM

GMAW Electric Wire Stick Out

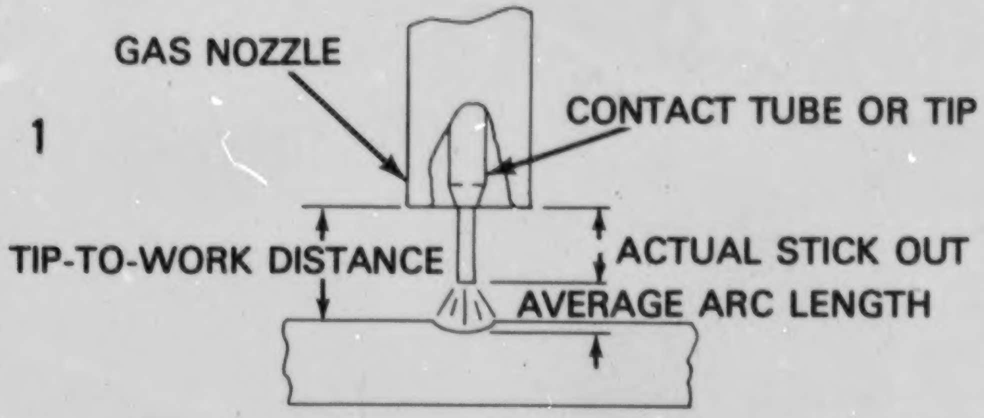

NOZZLE
TIP
WIRE
STICK OUT
WORKPIECE
TIP FLUSH
TIP EXTENDED
1/8" MAX.
TIP RECESSED
1/8" MAX.


GAS NOZZLE
CONTACT TUBE OR TIP
TIP-TO-WORK DISTANCE
ACTUAL STICK OUT
AVERAGE ARC LENGTH

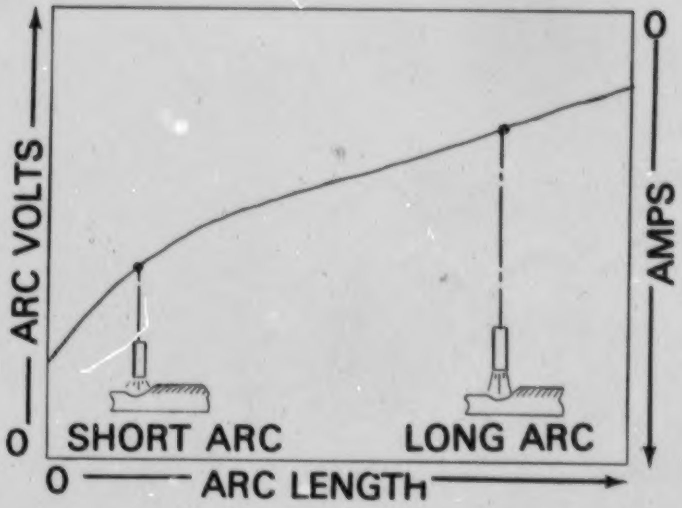
(STICK OUT IS TIP-TO-WORK)

Arc Length   Arc Volt-Amp Characteristics

1


GAS NOZZLE
CONTACT TUBE OR TIP
TIP-TO-WORK DISTANCE
ACTUAL STICK OUT
AVERAGE ARC LENGTH

2



1 SMALL CHANGE IN ARC VOLTS (ARC LENGTH CHANGED BY WELDER'S MOVEMENT OF GUN) RESULTS IN LARGE CHANGE OF WELDING CURRENT (AMPS)

2 SHORT ARC LENGTH = INCREASE AMPS = DECREASE ARC VOLTS
LONG ARC LENGTH = INCREASE ARC VOLTS = DECREASE AMPS

GAS METAL ARC WELDING
UNIT II

JOB SHEET #1--SET UP AND SHUT DOWN GMAW EQUIPMENT

I. Equipment and materials needed

  A. GMAW power supply, feeder wire, and gun (air-cooled)

  B. Shielding gas

    1. For mild steel--CO_2; C-25

    2. For stainless steel--Argon, C-25; Helium-Argon--CO_2; Argon-Oxygen (1-5%)

    3. For aluminum, copper, magnesium--Argon, Helium, or Argon-Helium mixes

  (NOTE: Flux cored welding is for steel only with or without shielding gas.)

  C. Electrode filler wire

    1. Solid or cored--Determined by base metal to be welded

    2. Wire diameters

      a. Short arc--.030", .035", .045"

      b. Spray arc--.045", 1/16", 3/64", 3/32"

      c. Flux cored--.045", 1/16", .68", 5/64", 3/32", 7/64", 1/8", 5/32"

  D. Current settings

    1. Short arc--DCRP--50-250 amps

    2. Spray arc--DCRP--250-450 amps

    3. Flux cored--DCRP--120-650 amps; DCSP--120-650 amps

  E. Voltage setting

    1. Short arc--12-30 arc volts

    2. Spray arc--24-36 arc volts

    3. Flux cored--20-38 arc volts

JOB SHEET #1

II. Set up procedure

A. Set up power supply controls as follows

1. Start welding machine--Push start switch or start engine if engine driven

2. Set machine controls

   a. Voltage

   b. Inductance (if equipped)

   c. Slope (if equipped)

B. Set up wire pad and shielding gas controls

1. Set up wire feed

   a. Correct size and type of wire

   b. Correct size feed roll or rolls

   c. Inch wire out to gun using incher control if equipped

   d. Adjust tension on feed rolls

   (NOTE: Tension should be tight enough to feed wire but should not deform or mark wire.)

   e. Turn on power switch

2. Set up and adjust shielding gas controls (if used)

   a. Blow out cylinder valve to remove any dirt or foreign material

   b. Mount gas flowmeter to cylinder in a vertical position

   c. Crack cylinder valve slowly

   (NOTE: Check for leaks using soapy water. Ivory soap should be used.)

   d. Turn wire speed control to zero or release pressure on feed rolls

   e. Open flowmeter adjusting valve slowly while depressing gun trigger

JOB SHEET #1

f. Adjust desired flow rate (c.f.h.) and release trigger (Figure 1)

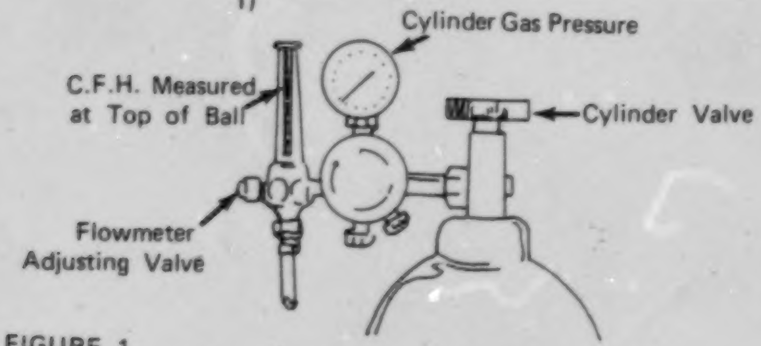


FIGURE 1

(NOTE: This is accurate only if gas in cylinder exceeds 50 p.s.i. and is mounted vertically.)

3. Set wire feed speed (amperage control) to desired setting

   (NOTE: Arc voltage and amps should be fine tuned while or after running ahead on scrap metal.)

C. Set up gun

1. Conduit and liners that transport wire to gun should be correct size as well as clean and free of obstructions

   (NOTE: Do not use solvents to clean nylon liners used for aluminum.)

2. Contact tip or tube should be correct size for wire being used and free of grease, dirt, or spatter

3. Nozzle should be of correct size for welding applications and gas flow volumes and free from spatter

   (NOTE: Some form of anti-spatter compound, either spray can or paste, should be applied to nozzle and contact tip before welding to help prevent spatter build up.)

4. Adjust and maintain correct stick out (Figure 2, next page)
   a. Short arc--1/4"-3/8"
   b. Spray arc--3/4"-1"

JOB SHEET #1

c. Flux cored--1/4"-2 1/2"

(NOTE: In this unit, stick out shall refer to the top-to-work distance.)

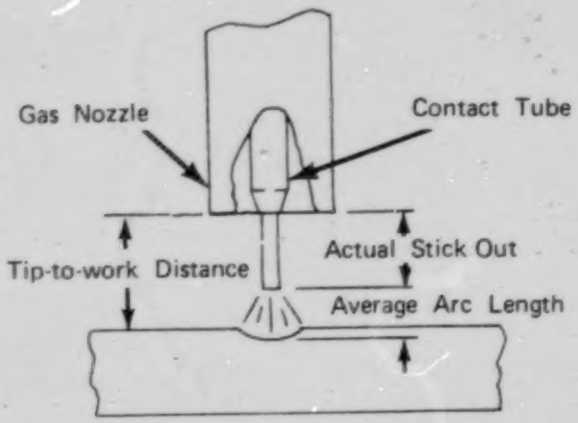

Gas Nozzle
Contact Tube
Tip-to-work Distance
Actual Stick Out
Average Arc Length

FIGURE 2

III. Shut down procedure

- A. Turn off wire feed speed control
    1. Set control to zero
    2. Move wire feed control switch to off after bleeding gas lines
- B. Shut off shielding gas system (if used)
    1. Close cylinder valve
    2. Depress welding gun trigger until ball in flowmeter zeros
    3. Close flowmeter adjusting valve finger tight
- C. Turn off welding power supply
- D. Store gun and cable assembly in correct place

GAS METAL ARC WELDING
UNIT II

JOB SHEET #2--CONSTRUCT A MULTIPLE PASS T-JOINT FILLET WELD IN THE HORIZONTAL POSITION

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas--CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E70S-3
- D. Current setting--DCRP 140-160 amps (wire feed speed)
- E. Voltage setting--19-21 arc volts
- F. Material--2 pieces 3/16" x 3" x 6" mild steel
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Position two plates to form a T-joint and tack (Figure 1)

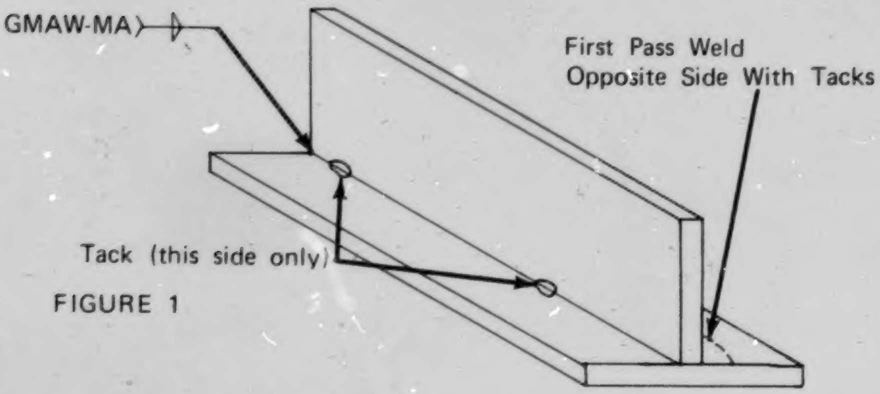


FIGURE 1

JOB SHEET #2

D. Maintain correct stick out of 1/4"-3/8" (Figure 2)

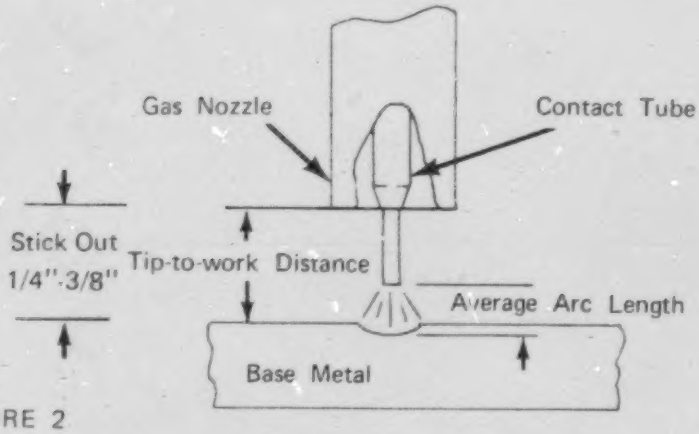
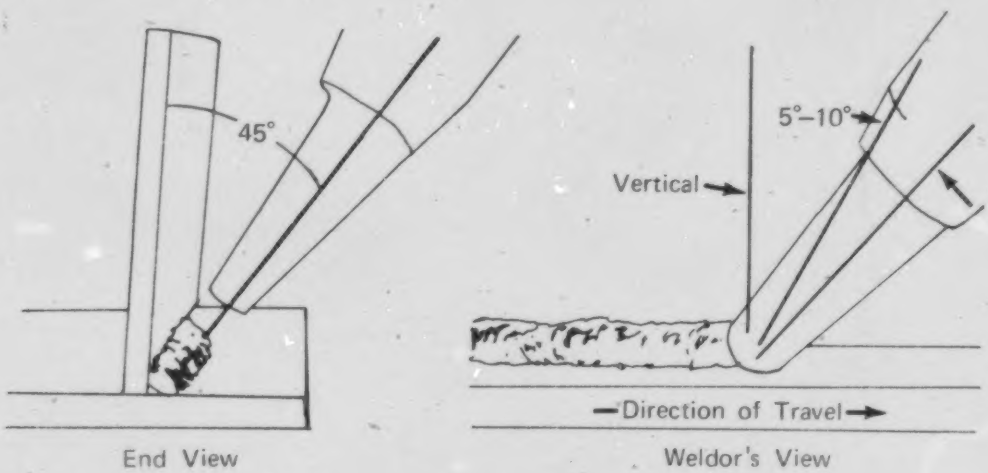

Gas Nozzle
Contact Tube
Stick Out 1/4"-3/8"
Tip-to-work Distance
Average Arc Length
Base Metal

FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in flat position

F. Position gun at 45° side angle and 5°-10° in direction of travel for first and second bead (Figure 3)


45°
5°–10°
Vertical
Direction of Travel

End View

Weldor's View

FIGURE 3

JOB SHEET #2

G. Start arc one inch from starting end of joint moving quickly to starting end of joint and begin first bead

(NOTE: This technique is used to prevent cold lap, a problem common to GMAW.)

H. Position gun at 60° angle to bottom plate for third and fourth beads and 30° angle to bottom for fifth and sixth beads (Figure 4)

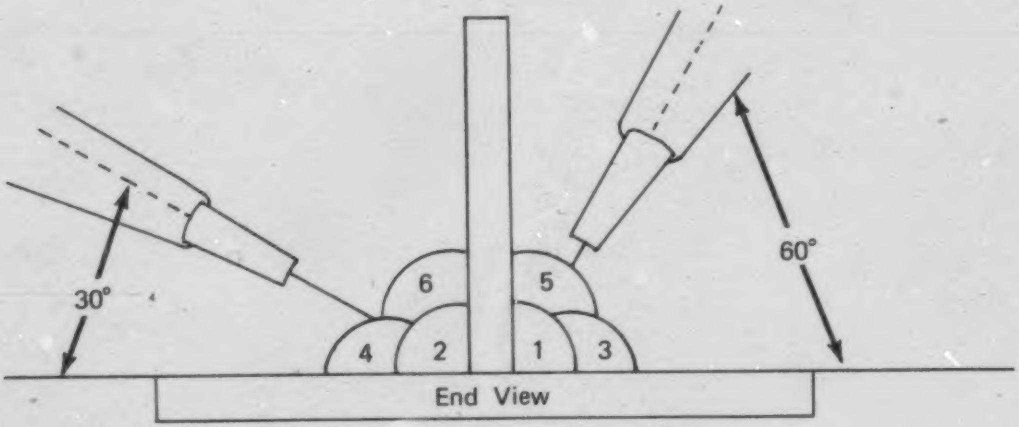
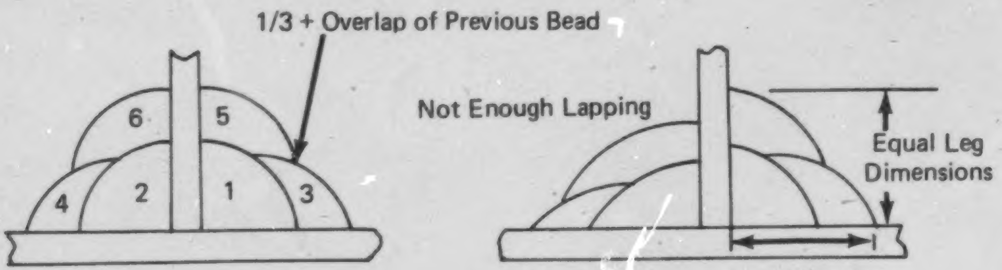

30°
60°
6
5
4
2
1
3
End View

FIGURE 4

I. Overlap all beads one-third (Figure 5)


1/3 + Overlap of Previous Bead
6
5
4
2
1
3
Not Enough Lapping
Equal Leg Dimensions

Bead Sequence

AVOID THIS

DO THIS

FIGURE 5

(NOTE: Remember to alternate beads to prevent distortion as shown in Figure 5.)

J. After completing required number of passes, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #3--CONSTRUCT A LAP JOINT FILLET WELD IN THE VERTICAL DOWN POSITION

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)

C. Electrode filler wire--.035 diameter A.W.S. #E705-3

D. Current setting-DCRP 140-160 amps (wire feed speed)

E. Voltage setting 19-21 arc volts

F. Material--2 pieces mild steel 3/16" x 3" x 6"

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 20 c.f.h.

C. Position two plates to form a lap joint and tack (Figure 1)

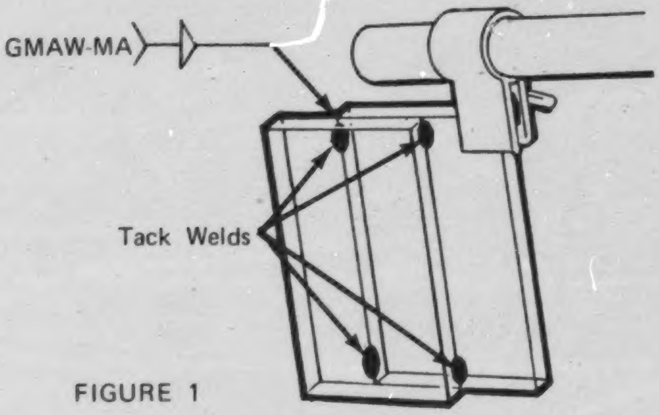


FIGURE 1

D. Position plate in vertical position as shown in Figure 1

JOB SHEET #3

E. Adjust and maintain correct stick out distance of 1/4-3/8 inch (Figure 2)

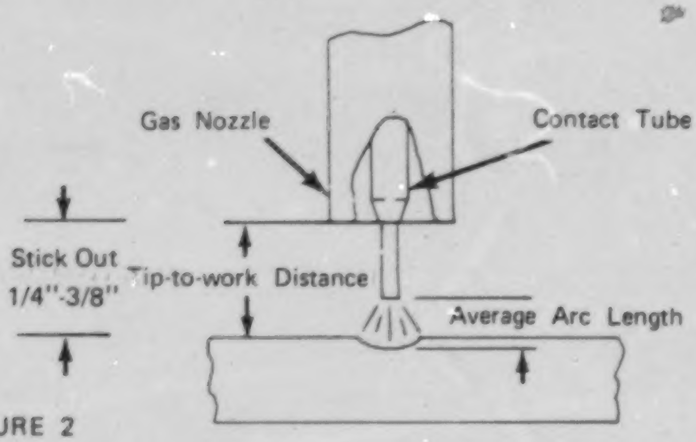
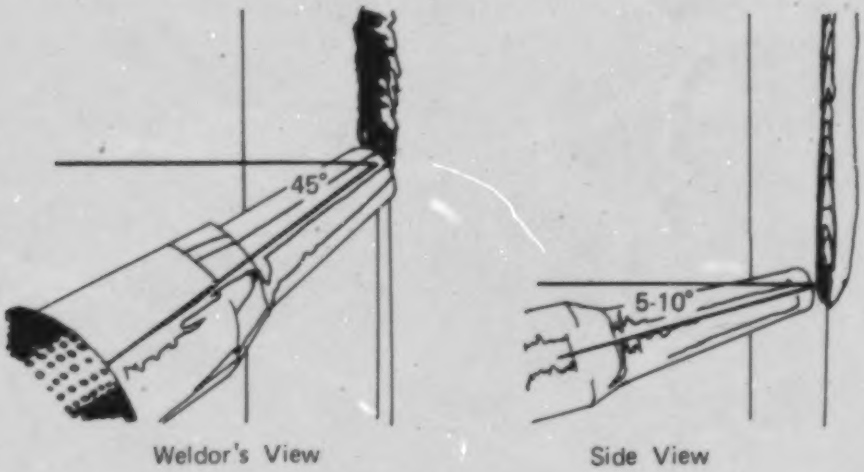

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

F. Position gun at 45° side angle and 5°-10° down from horizontal (Figure 3)



Weldor's View

Side View

FIGURE 3

JOB SHEET #3

G. Start arc approximately one inch from top of plates; then move to top and start weld progressing from top to bottom

(NOTE: Some starting technique similar to this should be used to prevent cold lap.)

H. Using a weaving motion, pause on the sides of the joint and travel at speed to fill joint completely (Figure 4)

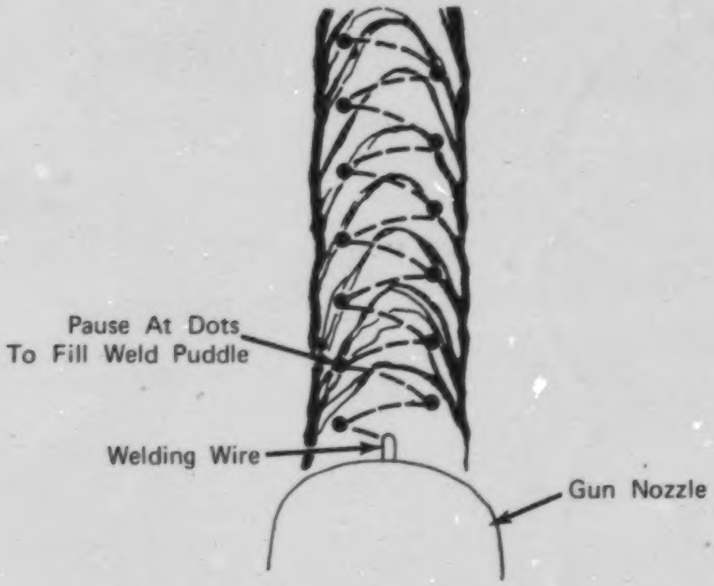

Pause At Dots
To Fill Weld Puddle
Welding Wire
Gun Nozzle

FIGURE 4

(NOTE: Check with instructor for complete details on electrode manipulation.)

I. Weld opposite side using same procedure

J. After completion of joint, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #4--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE FLAT POSITION WITH SHORT ARC

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 110-120 amps (wire feed speed)
- E. Voltage setting 16-19 arc volts
- F. Material--2 pieces mild steel 3/16" x 3" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Position material to form a butt joint with 1/8" root gap and tack (Figure 1)

  (NOTE: Be sure root gap spacing is slightly wider than 1/8" to allow for shrinking of tack and that joint is aligned before tacking. One-eighth inch mild steel filler rod can be used to gap the joint.)

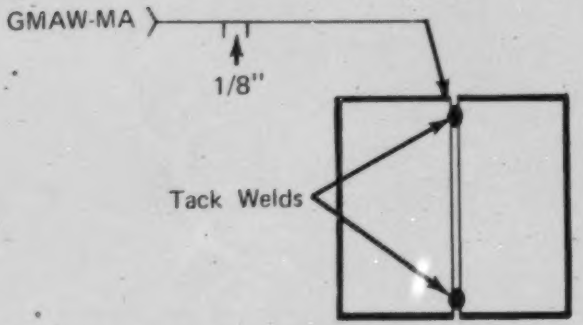


FIGURE 1

JOB SHEET #4

D. Adjust and maintain during welding procedure a stick out of 1/4-3/8 inch (Figure 2)

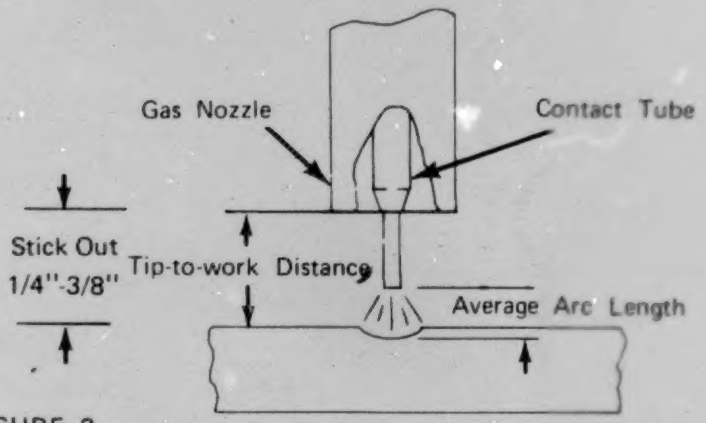

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

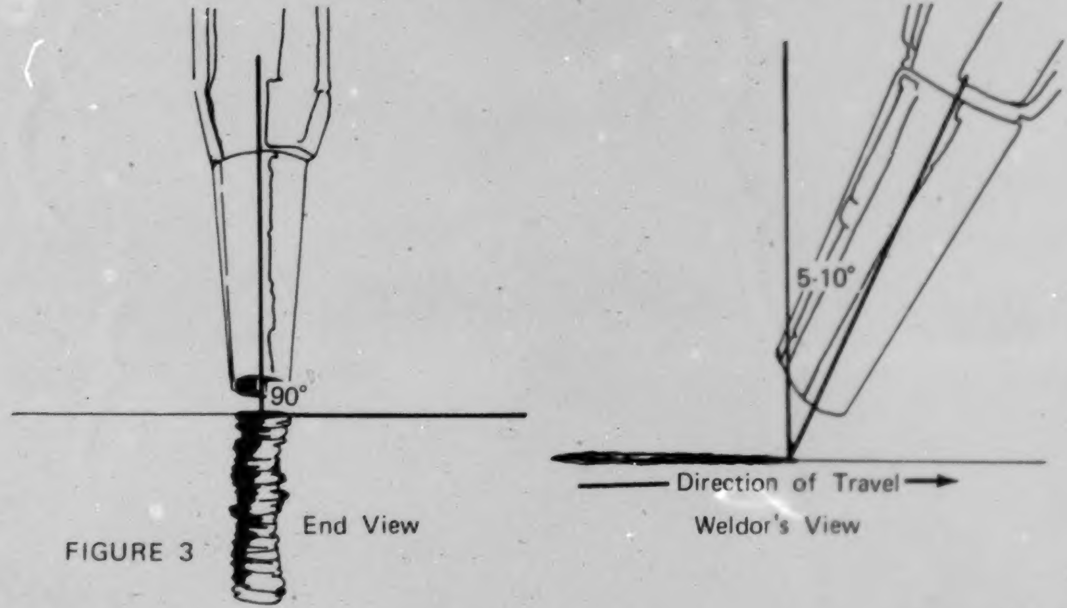
FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in flat position

(NOTE: Space metal off table to avoid welding to table through root of joint.)

F. Hold gun in vertical position and 5°-10° in direction of travel (Figure 3)


90°
5-10°
Direction of Travel →

End View

Weldor's View

FIGURE 3

JOB SHEET #4

G. Start arc 1/2"-3/4" from end of joint; then move to end of joint and begin welding keeping the following points in mind

1. Travel at a speed to penetrate the joint completely (Figure 4)

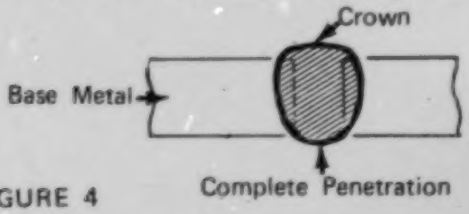

Crown
Base Metal
Complete Penetration

FIGURE 4

2. Bead crown should be higher than surface of base metal

3. Electrode wire should be fed into leading edge of puddle being careful to avoid pushing wire through root of joint and out back of plates making whiskers

4. Weld puddle can be controlled by a whipping and pause motion of electrode (Figure 5)

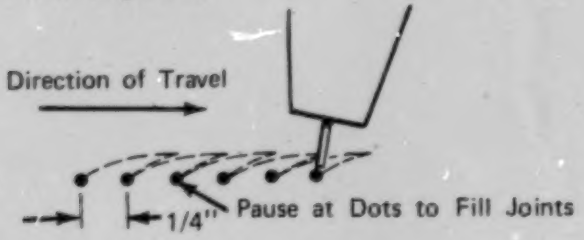

Direction of Travel
1/4"
Pause at Dots to Fill Joints

FIGURE 5

5. Avoid excessive lengthening of stick out when oscillating gun

6. Varying electrode can be helpful in controlling weld bead

H. At end of joint, be sure to fill crater

I. Inspect root of weld for correct penetration and turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #5--CONSTRUCT A SQUARE GROOVE BUTT JOINT IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Equipment and materials needed

  A. GMAW power supply, wire feeder, and air cooled gun for short arc application

  B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)

  C. Electrode filler wire--.035 diameter A.W.S. #E705-3

  D. Current setting--DCRP 110-120 amps (wire feed speed)

  E. Voltage setting 16-19 arc volts

  F. Material--2 pieces mild steel 3/16" x 3" x 6"

  G. Personal protective equipment

II. Procedure

  A. Adjust power supply and wire feeder to correct voltage and amperage

  B. Set shielding gas flow rate 20 c.f.h.

  C. Position material to form a butt joint with 1/8" root gap and tack (Figure 1)

  (NOTE: Be sure root gap spacing is slightly wider than 1/8" to allow for shrinking of tack and that joint is aligned before tacking. One-eighth inch mild steel filler rod can be used to gap the joint.)

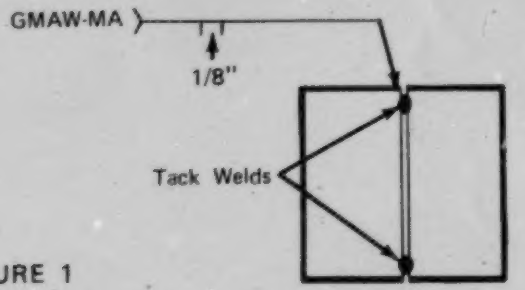


FIGURE 1

JOB SHEET #5

D. Adjust and maintain during welding procedure a stick out of 1/4-3/8 inch (Figure 2)

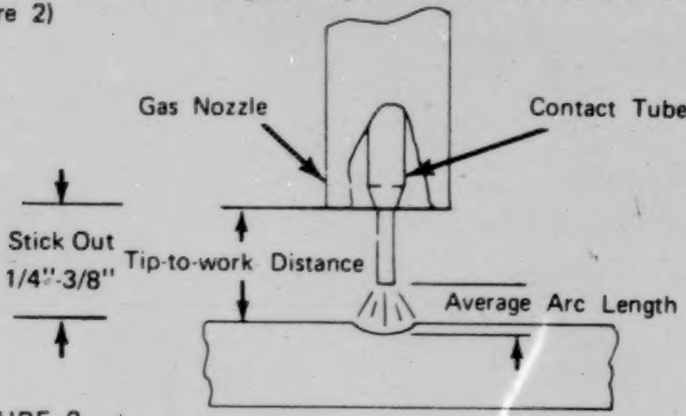

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in the horizontal position (Figure 3)

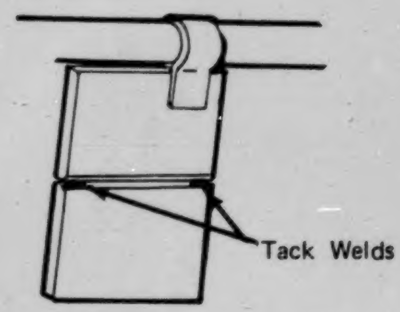
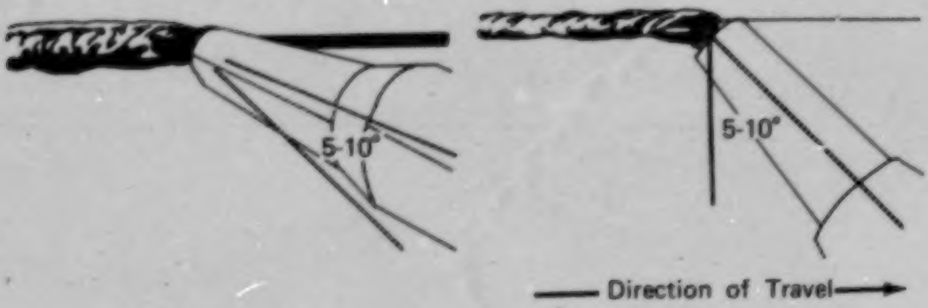


FIGURE 3

JOB SHEET #5

F. Position gun 5°-10° down from horizontal and 5°-10° in direction of travel (Figure 4)



Weldor's View

Top View

FIGURE 4

G. Start arc 1/2"-3/4" from end of joint to avoid cold lap; then move to end of joint and begin welding keeping in mind the following points

1. Travel at speed to penetrate joint completely
2. Some form of electrode manipulation will be helpful in controlling puddle
3. Feed electrode filler wire into leading edge of puddle being careful to avoid getting too close or wire will plunge through to root side of weld causing whiskers to develop

H. Be sure to fill crater at end of joint

I. Inspect weld for complete penetration at the root and turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #6--CONSTRUCT A MULTIPLE PASS T-JOINT FILLET WELD IN THE VERTICAL UP POSITION WITH SHORT ARC FOR BREAK TEST

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire-.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 120-140 amps (wire feed speed)
- E. Voltage setting 18-21 arc volts
- F. Material--2 pieces mild steel 1/4" to 3/8" x 3" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Position two plates to form a T-joint and tack (Figure 1)

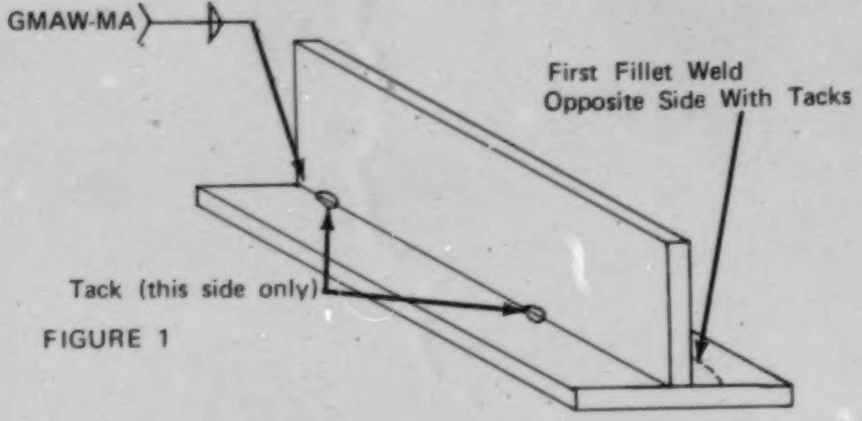


FIGURE 1

JOB SHEET #6

D. Adjust gun to correct stick out (Figure 2)

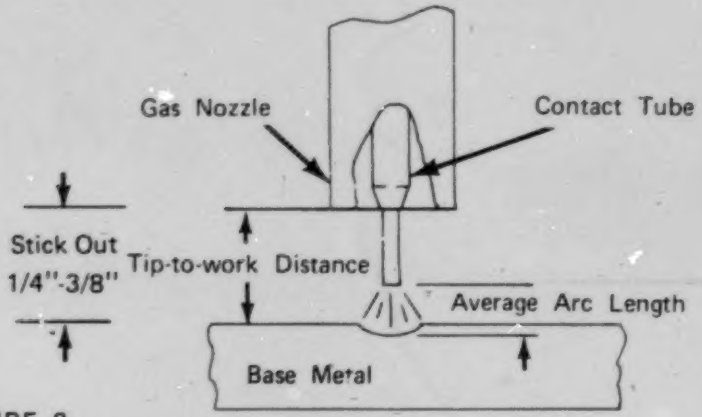

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length
Base Metal

FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Place metal in vertical position (Figure 3)

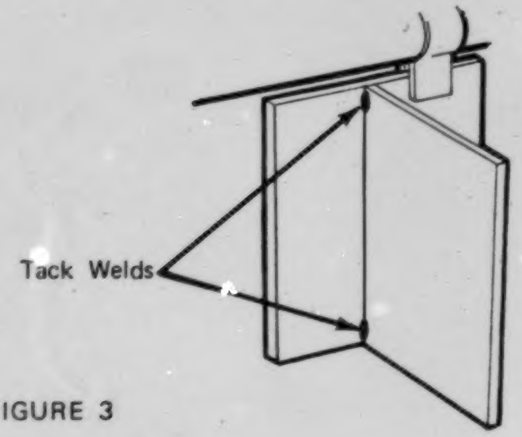
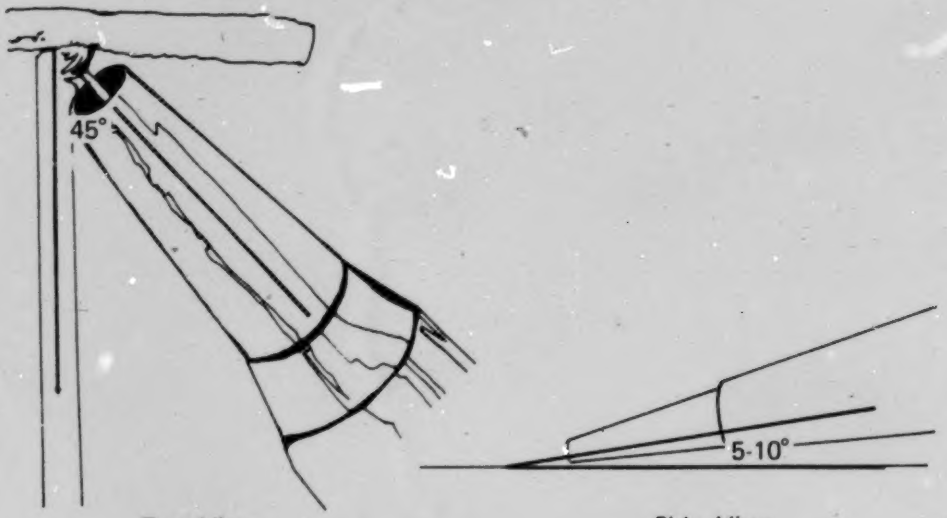


FIGURE 3

JOB SHEET #6

F. Position gun at 45° side angle and 5°-10° down from horizontal (Figure 4)



Top View

Side View

FIGURE 4

G. Start arc approximately 1" above bottom of joint; then move to bottom and start welding upward using some form of electrode manipulation

H. Travel at a speed to produce a bead face about 1/4" to 5/16" wide; second bead will be about 7/16" to 1/2" wide (Figure 5)

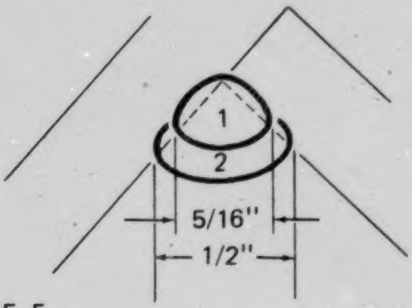


FIGURE 5

JOB SHEET #6

I. When welding second bead, pause at the edges of first bead to fill the crater and avoid undercutting sides of joint (Figure 6)

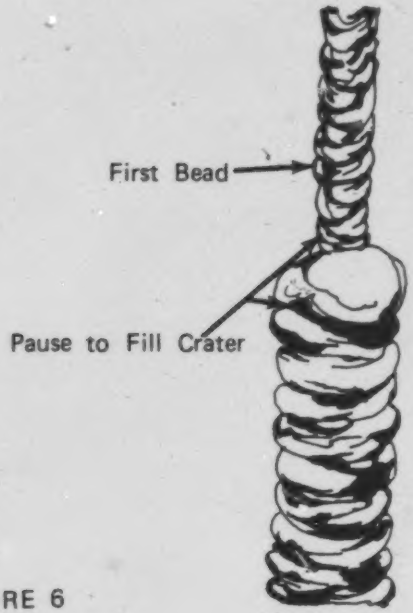


FIGURE 6

(NOTE: Check with instructor for specific instructions on electrode manipulation techniques.)

J. Cool metal and weld opposite side using same procedure as on first side

K. After completion of joint, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #7--CONSTRUCT A CORNER JOINT FILLET WELD IN THE VERTICAL UP POSITION WITH SHORT ARC FOR BREAK TEST

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 120-140 amps (wire feed speed)
- E. Voltage setting 18-19 arc volts
- F. Material--2 pieces mild steel 1/4" x 3" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Position two plates to form a corner joint and tack on the back side of the joint (Figure 1)

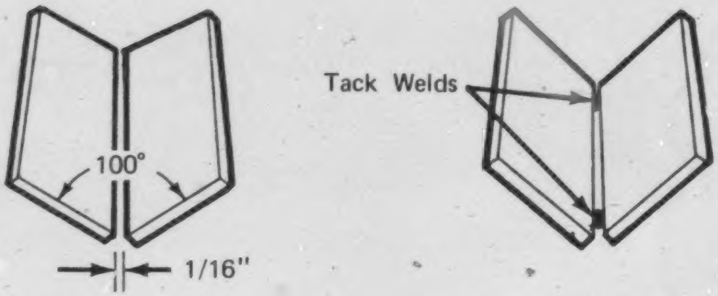


FIGURE 1

JOB SHEET #7

D. Adjust gun to correct stick out and clean nozzle if needed (Figure 2)

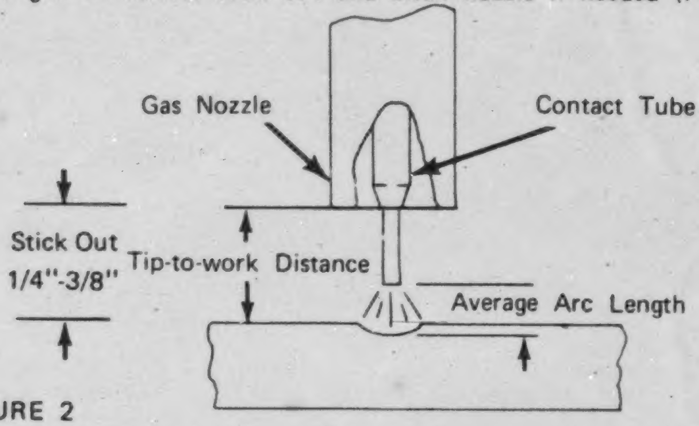
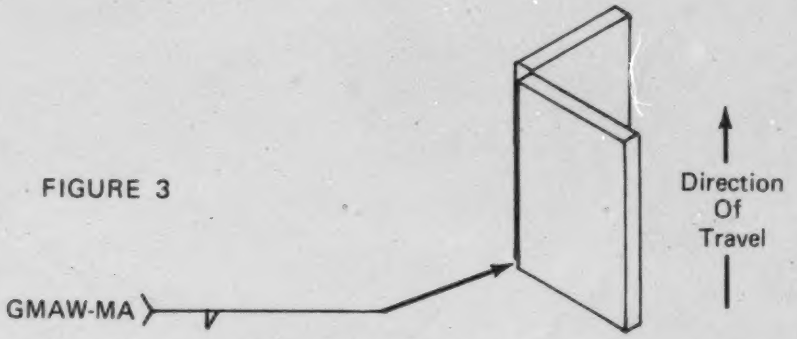

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 2

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

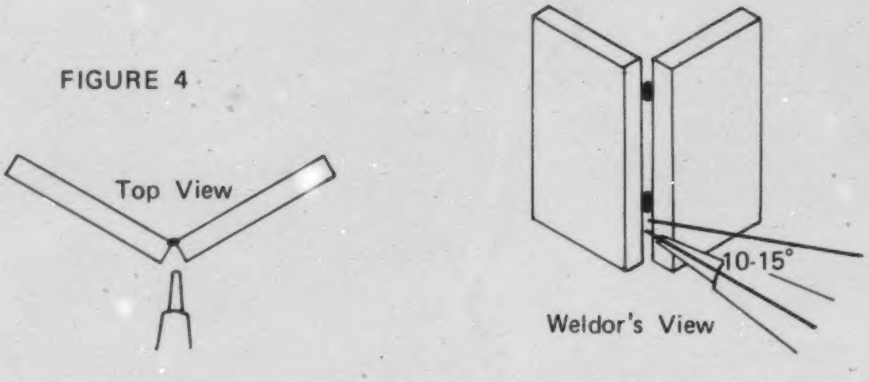
E. Place metal in vertical position (Figure 3)

FIGURE 3


Direction
Of
Travel
GMAW-MA

F. Position gun straight into joint and down from horizontal 10°-15° (Figure 4)

FIGURE 4


Top View
10-15°
Weldor's View

JOB SHEET #7

G. Start arc 3/4" to 1" above bottom of plate; then quickly move to bottom and start weld using some type of electrode manipulation to control puddle; pause at the edge of the joint to prevent undercuts

(NOTE: Check with instructor for insert of specific information on electrode manipulations.)

H. Travel at a speed to completely penetrate joint leaving the face and root of the bead with a slight crown (Figure 5)

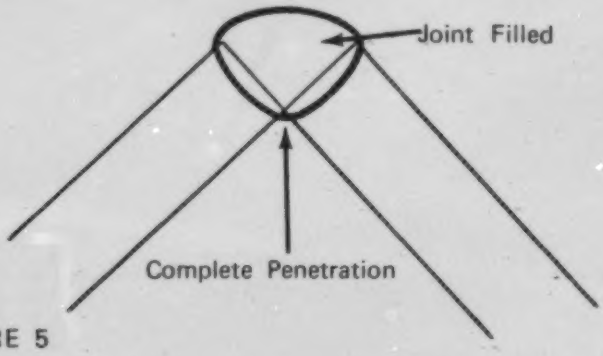


FIGURE 5

(NOTE: Keep the electrode in the leading edge of the puddle and control the penetration by adjusting the electrode stick out and travel speed. Be careful to avoid feeding the electrode through the back of the plates as this causes whiskers.)

I. About half-way up joint, break the arc, restart the arc, move back to bead, and continue welding (Figure 6)

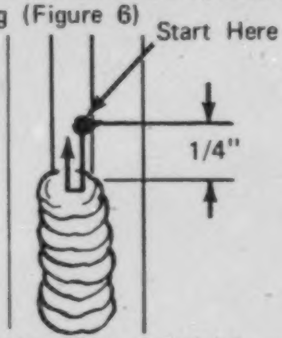


FIGURE 6

(NOTE: This technique will be helpful in eliminating cold laps.)

J. After welding is complete, check for even penetration at the root and for a well formed face without undercut

(NOTE: Dip test plate in water while hot to make weld easier to break.)

K. After instructor's approval, test weld

JOB SHEET #7

L. Place test plate in a hydraulic press or hit with hammer and compress until joint breaks (Figure 7)

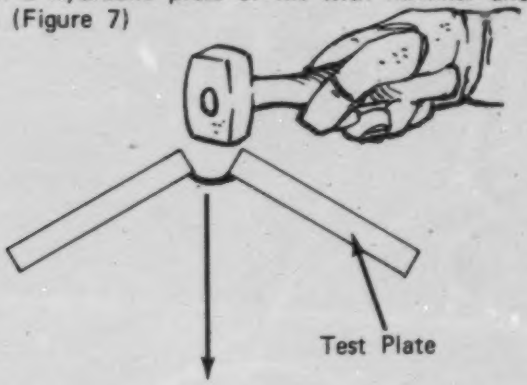


FIGURE 7

M. Weld should break uniformly down the center of weld joint the entire length of the weld

N. There should be complete fusion between both plates and to the root of the weld

O. After testing weld, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #8--CONSTRUCT A SQUARE GROOVE BUTT WELD IN THE VERTICAL UP POSITION WITH SHORT ARC

I. Equipment and materials needed

  A. GMAW power supply, wire feeder, and air cooled gun for short arc application

  B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)

  C. Electrode filler wire--.035 diameter A.W.S. #E705-3

  D. Current setting--DCRP 110-120 amps (wire feed speed)

  E. Voltage setting 16-19 arc volts

  F. Material--2 pieces mild steel 3/16" x 3" x 6"

  G. Personal protective equipment

II. Procedure

  A. Adjust power supply and wire feeder to correct voltage and amperage

  B. Set shielding gas flow rate 20 c.f.h.

  C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

  (NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

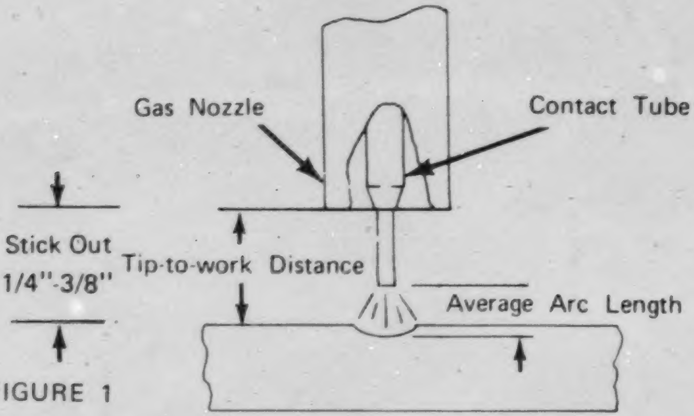


FIGURE 1

JOB SHEET #8

D. Position material to form a butt joint with 1/8" root gap and tack weld

(NOTE: A 1/8" mild steel filler rod can be used to gap the joint. Be sure to allow for shrinking of the tack by spacing slightly wider than the 1/8" filler rod.)

E. Place metal in a vertical position for welding (Figure 2)

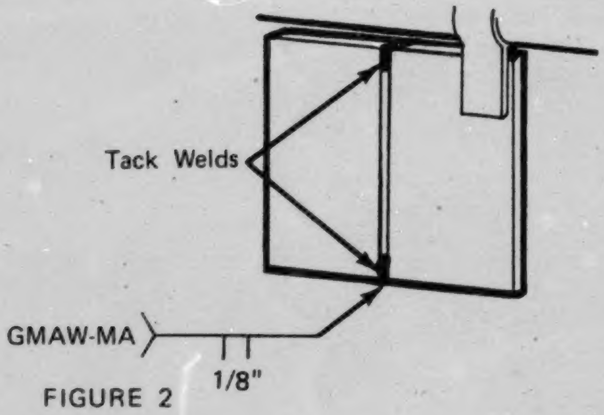

Tack Welds
GMAW-MA
1/8"

FIGURE 2

F. Position gun straight into joint (90°) and angled 5°-10° down from horizontal (Figure 3)

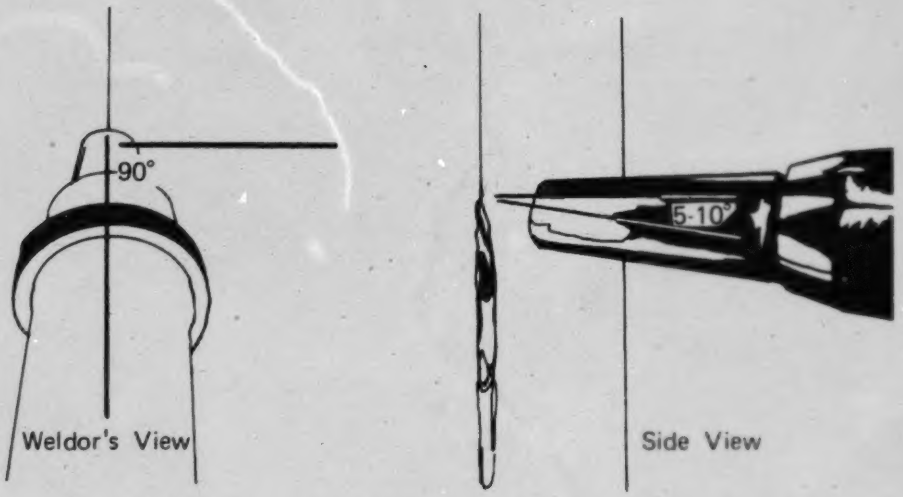

90°
5-10°
Weldor's View
Side View

FIGURE 3

JOB SHEET #8

G. Start arc 1/2" to 3/4" up from bottom of joint; then move to bottom end of joint and begin welding using some type of weaving motion (Figure 4)

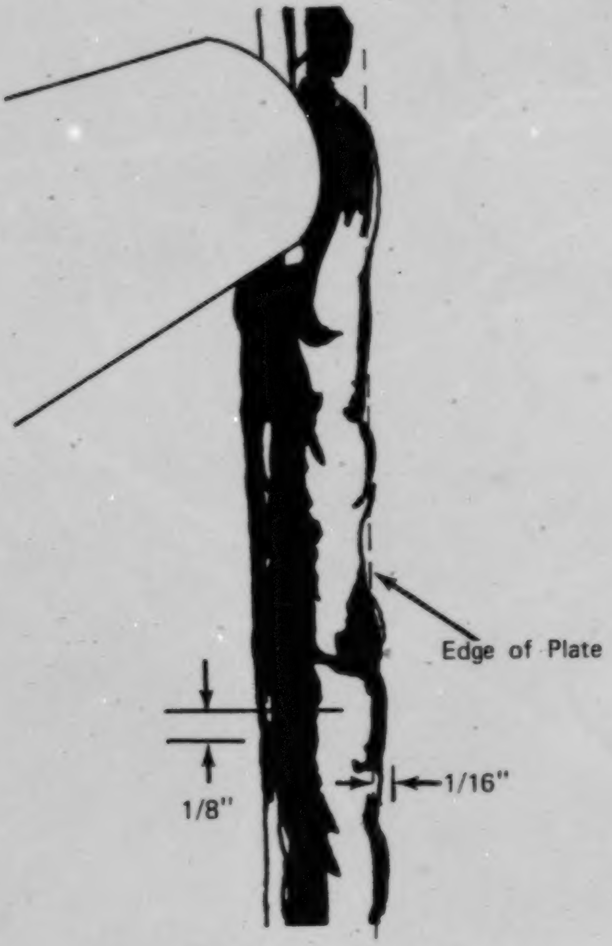


FIGURE 4

(NOTE: Care should be taken to keep electrode wire in leading edge of puddle with a stick out distance of 1/4"-3/8".)

H. Travel at a speed to penetrate joint completely and regulate penetration and bead size by increasing or decreasing travel speed and electrode stick out

(NOTE: Adjust wire feed as a last resort.)

I. Fill crater at end of joint by reversing travel about 1/4" in opposite direction

JOB SHEET #8

J. Inspect weld for complete penetration at the root with a slight crown (Figure 5)

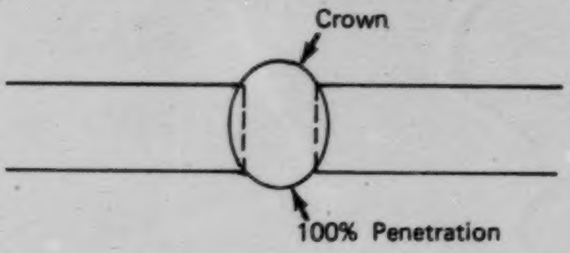

Crown
100% Penetration

FIGURE 5

K. Turn in to instructor for approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #9--CONSTRUCT A T-JOINT FILLET WELD IN THE OVERHEAD POSITION WITH SHORT ARC FOR BREAK TEST

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 140-160 amps (wire feed speed)
- E. Voltage setting 19-21 arc volts
- F. Material--2 pieces mild steel 1/4" x 3" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20 c.f.h.
- C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

  (NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

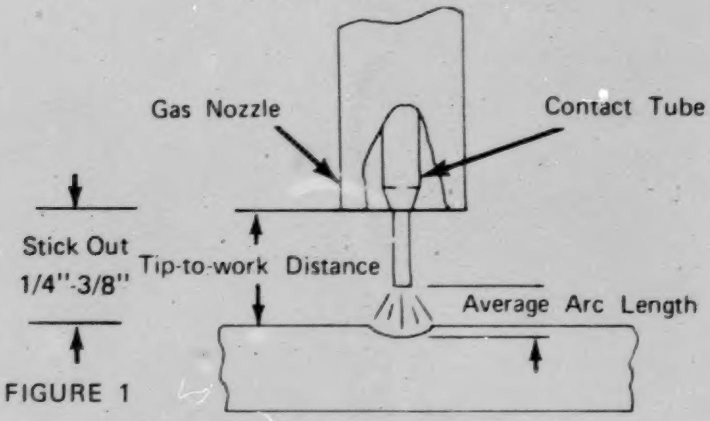


FIGURE 1

JOB SHEET #9

D. Position plates to form a T-joint and tack (Figure 2)

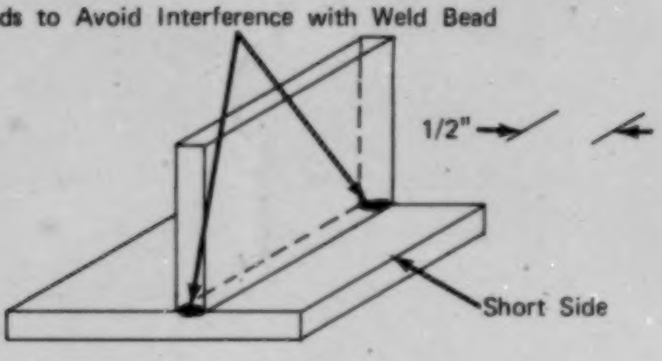

Tack Ends to Avoid Interference with Weld Bead
1/2"
Short Side

FIGURE 2

(NOTE: Be sure to place top plate no closer than 1/2" from edge of bottom plate. At instructor's approval, plates can be gapped to increase penetration at the root of the weld.)

E. Clamp metal in overhead position (Figure 3)

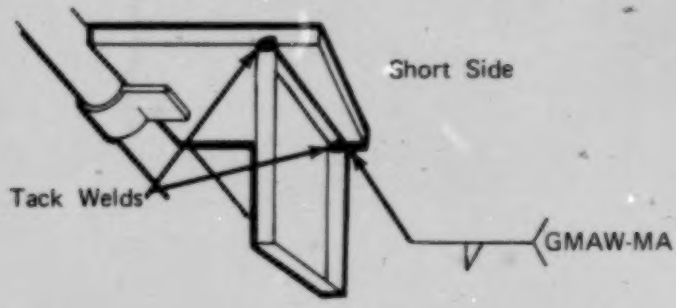
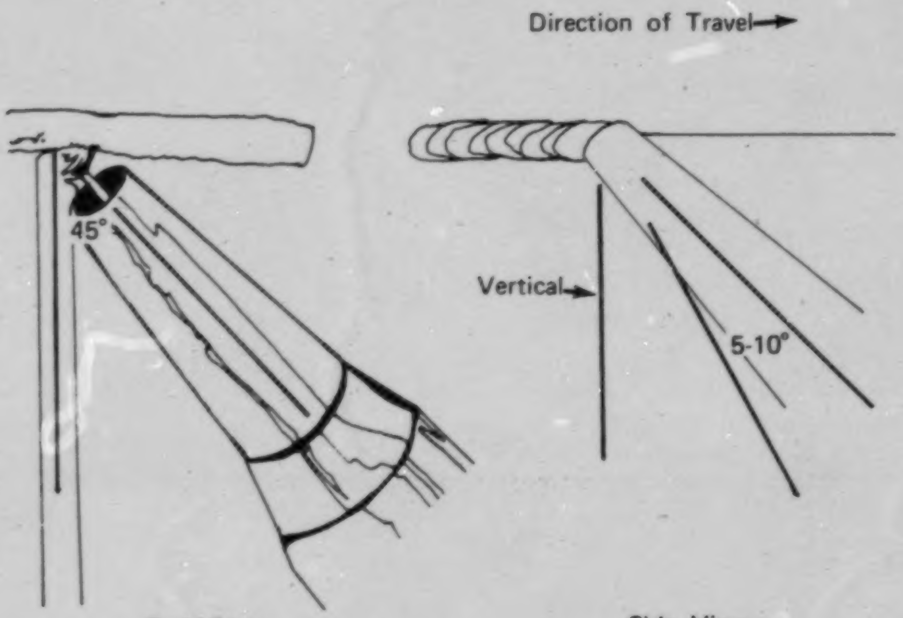

Short Side
Tack Welds
GMAW-MA

FIGURE 3

JOB SHEET #9

F. Position gun at a 45° side angle and 5°-10° in direction of travel (Figure 4)



End View

Side View

FIGURE 4

G. Start arc in joint 1/2"-1" from starting end; then move to end and begin welding

(NOTE: Maintain stick out distance of 1/4"-3/8".)

H. Travel at a speed to produce a bead face 5/16" wide

I. Electrode may be held steadily or manipulated as weld progresses down joint

(NOTE: Check with instructor for specific details on this step.)

J. Half-way down the joint, break the arc and restart

K. To restart arc, move gun 1/2" to 3/4" down joint in front of weld bead, start arc, move electrode back to leading edge of weld bead, and begin welding (Figure 5)

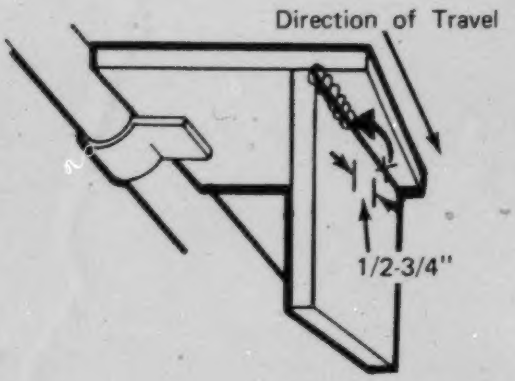

Direction of Travel
1/2-3/4"

FIGURE 5

L. Fill crater at end of joint by reversing travel about 1/4" in opposite direction

M. After weld bead is finished, check for undercuts and bead appearance and uniform size (Figure 6)

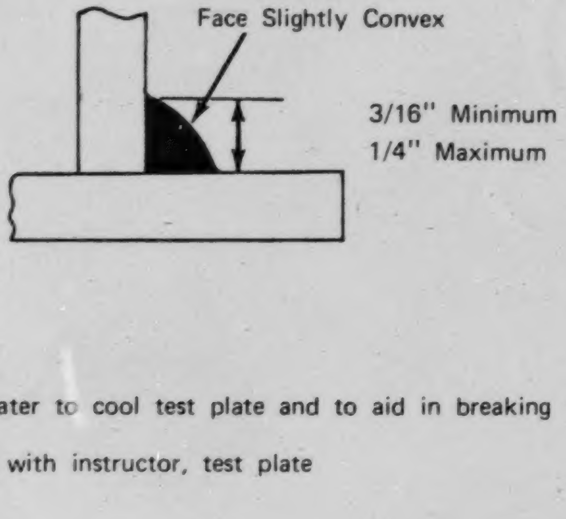

Face Slightly Convex
3/16" Minimum
1/4" Maximum

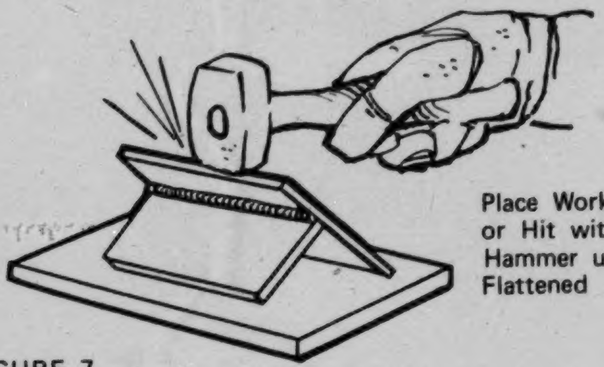
FIGURE 6

N. Dip weld in water to cool test plate and to aid in breaking

O. After checking with instructor, test plate

JOB SHEET #9

P. Break plate with a hammer or hydraulic press (Figure 7)



Place Workpiece in Press or Hit with Two Pound Hammer until Broken or Flattened

FIGURE 7

Q. Weld should break uniformly down the center of the weld joint the entire length of the weld (Figure 8)

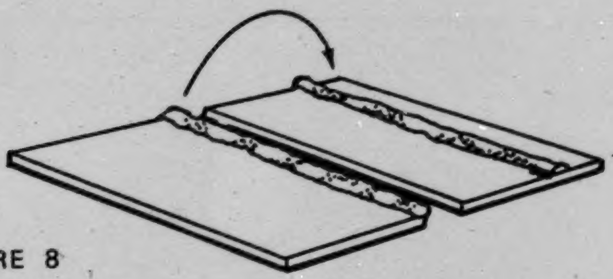


FIGURE 8

(NOTE: Break should be through center of bead for entire length of weld.)

R. There should be complete fusion between both plates and the root of the weld

S. After testing weld, turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #10--CONSTRUCT A SQUARE GROOVE BUTT WELD IN THE OVERHEAD POSITION WITH SHORT ARC

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas CO_2 or C-25 at 20 c.f.h. (25%--CO_2; 75% argon)

C. Electrode filler wire--.035 diameter A.W.S. #E705-3

D. Current setting--DCRP 110-120 amps (wire feed speed)

E. Voltage setting 16-19 arc volts

F. Material--2 pieces mild steel 3/16" x 3" x 6"

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 20 c.f.h.

C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

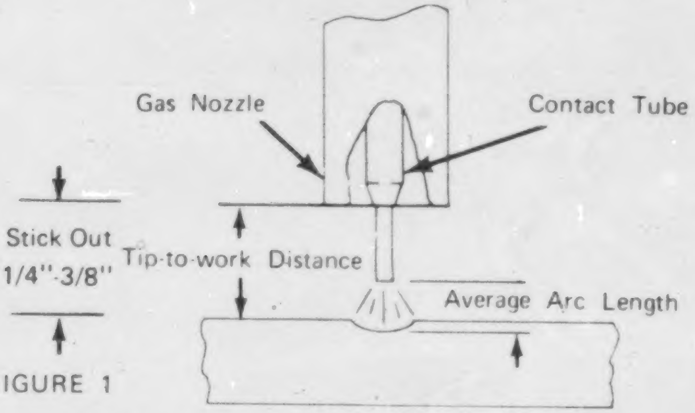


FIGURE 1

JOB SHEET #10

D. Position material to form a butt joint with 1/8" root gap and tack weld

(NOTE: A 1/8" mild steel filler rod can be used to gap the joint. Be sure to allow for shrinking of the tack by spacing slightly wider than the 1/8" filler rod.)

E. Place metal in the overhead position for welding (Figure 2)

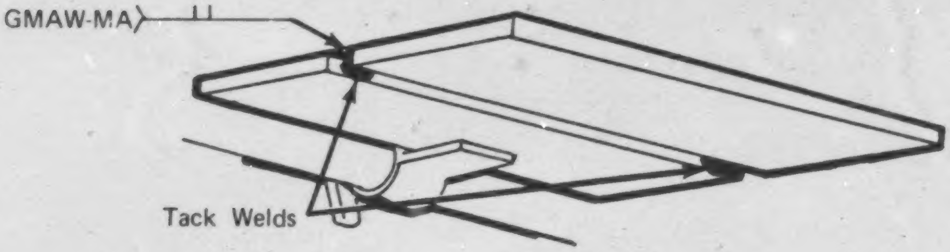
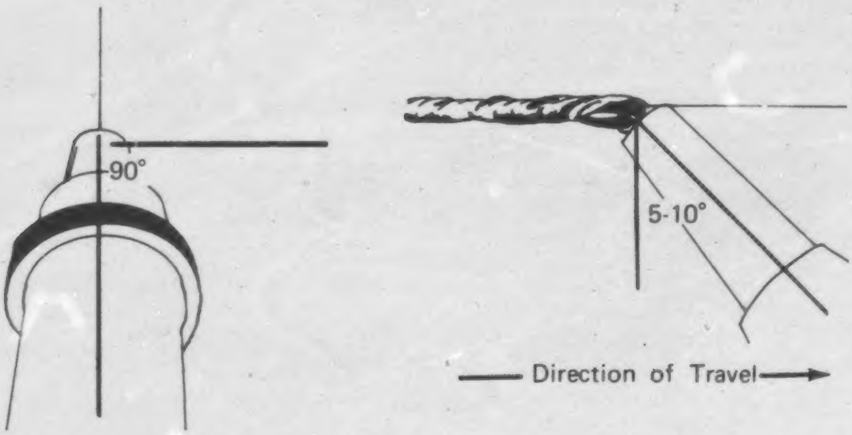


FIGURE 2

F. Position gun at a 90° side angle straight up into middle of joint and angled 5°-10° in direction of travel (Figure 3)



End View

Weldor's View

FIGURE 3

JOB SHEET #10

G. Start arc 3/4" to 1" down the joint; then move to end and begin welding using some type of weaving manipulation (Figure 4)

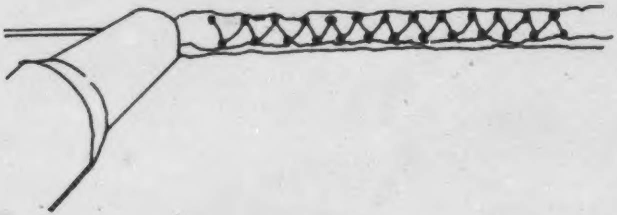


FIGURE 4

(NOTE: Consult instructor for specific instructions on electrode manipulation.)

H. Travel at a speed that will penetrate joint 100% regulating penetration and bead size by travel speed, electrode angle, and stick out (Figure 5)

(NOTE: Adjust wire feed as a last resort.)

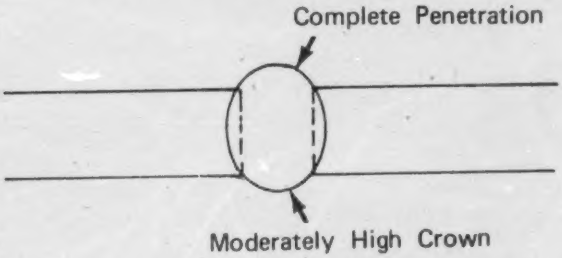


FIGURE 5

(NOTE: Keep electrode wire in leading edge of puddle with an average stick out distance of 1/4" to 3/8".)

I. Fill crater at end of joint by reversing travel 1/4" in opposite direction

J. Inspect weld for complete penetration and correct bead size

(NOTE: See Figure 5.)

K. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #11--CONSTRUCT A T-JOINT FILLET WELD IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas CO_2 or C-25 at 15-20 c.f.h. (25%--CO_2; 75% argon)

(NOTE: C-25 is the preferred gas due to less penetration.)

C. Electrode filler wire--.035 diameter A.W.S. #E705-3

(NOTE: .030 wire can be substituted for .035.)

D. Current setting--DCRP 110-120 amps (wire feed speed)

E. Voltage setting 15-18 arc volts

F. Material--2 pieces mild steel 16 ga. x 3" x 6"

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 15-20 c.f.h.

C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

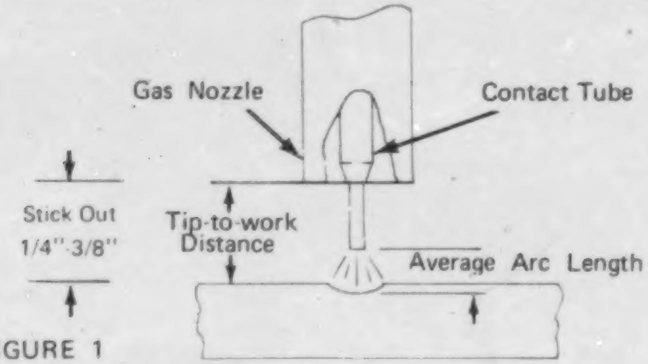


FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #11

D. Position material to form a T-joint and tack weld (Figure 2)

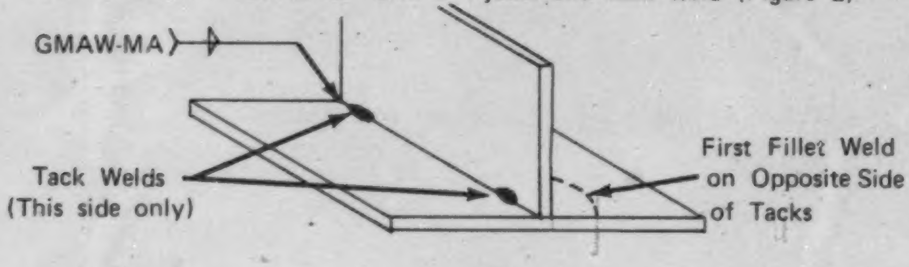
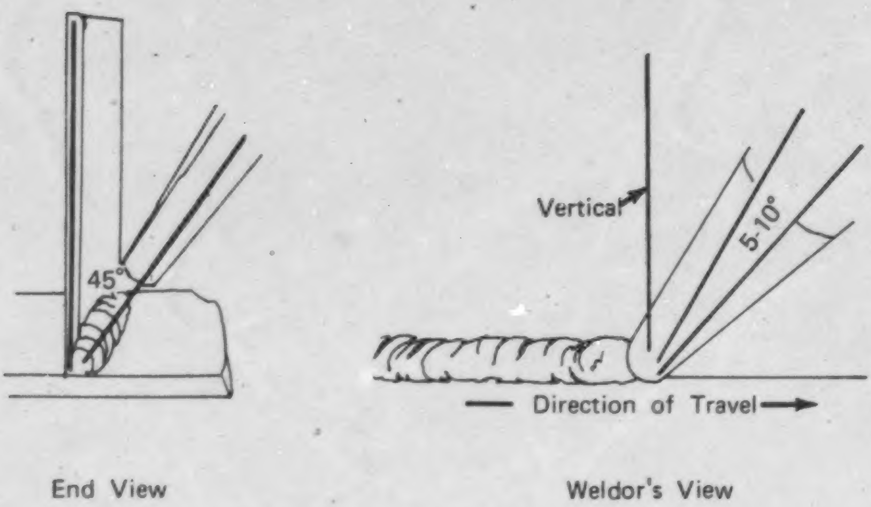

GMAW-MA
Tack Welds
(This side only)
First Fillet Weld
on Opposite Side
of Tacks

FIGURE 2

E. Position metal flat on table for welding

F. Position gun at 45° side angle and 5°-10° in direction of travel (Figure 3)


45°
Vertical
5-10°
Direction of Travel

End View

Weldor's View

FIGURE 3

(NOTE: Normal direction of travel would be from left to right with the back hand technique. The forehand technique can be used on thinner gauge metals where over penetration is a problem.)

JOB SHEET #11

G. Start arc 1/2" to 3/4" from starting end of joint, move electrode back to starting point, begin weld at the end of joint, reverse electrode travel for 1/4", and fill crater

(NOTE: This technique is used to prevent cold lap and crater cracks.)

H. Travel speed will be faster on thinner gauge metals but stick out will be the same

I. Cool metal and weld other side using the same procedure

J. Inspect joint for improper starts, finishes, cold lap, or distortion of the workpiece

K. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #12--CONSTRUCT A SINGLE V-GROOVE BUTT JOINT IN THE HORIZONTAL POSITION WITH SHORT ARC FOR TEST

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas CO_2 or C-25 at 20-30 c.f.h. (25%--CO_2; 75% argon)

C. Electrode filler wire--.035 diameter A.W.S. #E705-3

D. Current setting--DCRP 120-130 amps (wire feed speed)

E. Voltage setting 18-20 arc volts

F. Material--2 pieces mild steel 3/8" x 3" x 6"

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 20-30 c.f.h.

C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

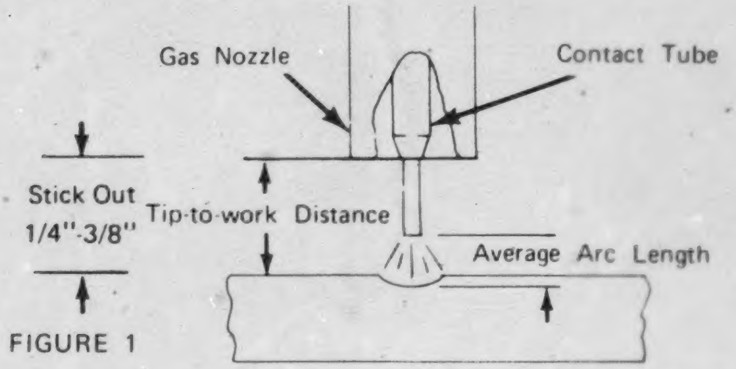


FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #12

D. Prepare metal by beveling one long side of each plate (Figure 2)

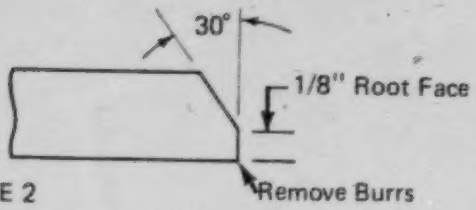
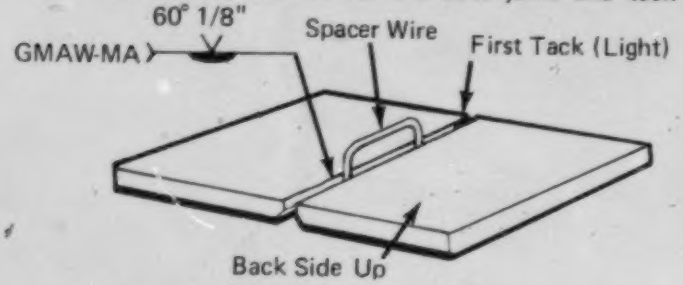

30°
1/8" Root Face
Remove Burrs

FIGURE 2

Grind 1/8" Root Face

Remove Burrs on Back Side of Plate

E. Position material to form a butt joint and tack weld (Figure 3)


60° 1/8"
GMAW-MA
Spacer Wire
First Tack (Light)
Back Side Up

Separate Plates with 1/8" U-Shaped Wire Spacer

FIGURE 3

(NOTE: Deposit light tack at one end; then deposit 1/4" tack at other end removing 1/8" wire immediately.)

F. Grind tack with right angle grinder to a minimum (1/16") thickness (Figure 4)

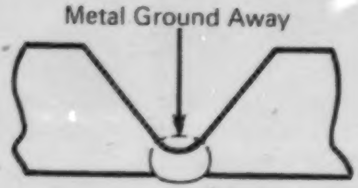

Metal Ground Away

FIGURE 4

(NOTE: Grind sides to smooth round contour. Grind ends to a sharp, feathered edge.)

G. Place metal in horizontal position for welding (Figure 5)

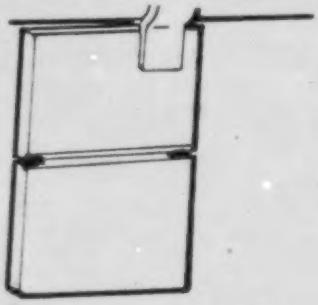


FIGURE 5

JOB SHEET #12

H. Position electrode 5° up from horizontal and 5°-10° in direction of travel (Figure 6)

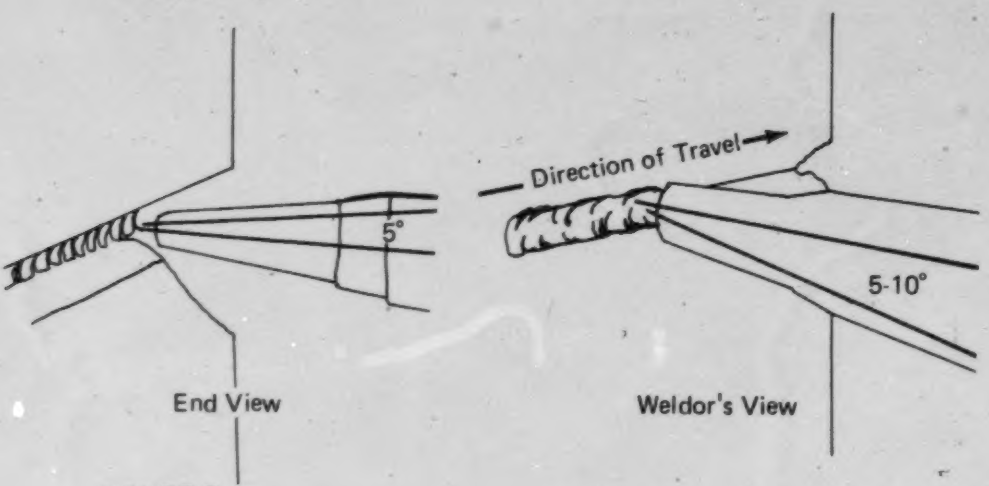

5°
Direction of Travel
5-10°
End View
Weldor's View

FIGURE 6

I. Start arc 3/4"-1" from starting end of joint; then move electrode back to starting point and begin root pass

J. Travel smoothly using some type of electrode manipulation with the electrode near the leading edge of the puddle

(CAUTION: Avoid moving wire past leading edge of puddle or wire will plunge through root opening.)

K. Travel at speed to fill joint and produce a bead face width of 5/16" with a 1/16" crown (Figure 7)

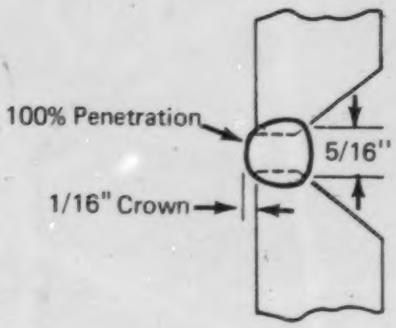
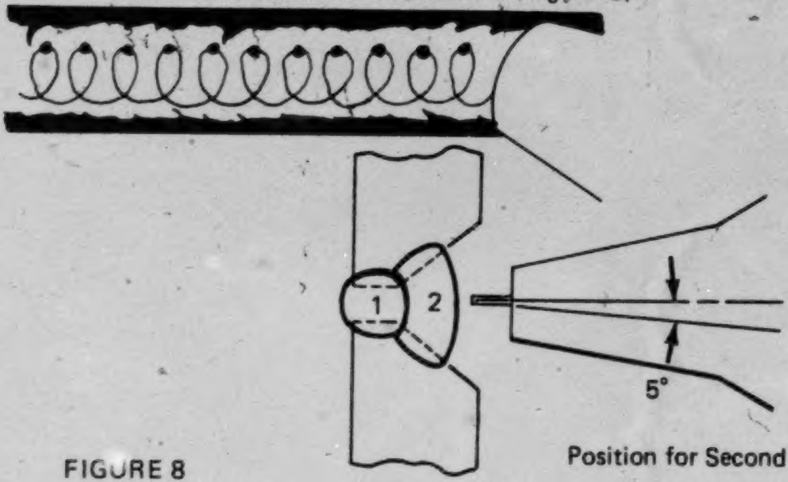

100% Penetration
5/16"
1/16" Crown

FIGURE 7

(NOTE: Penetration can be controlled by varying electrode stick out, angle, and travel speed and by washing electrode on sides of groove.)

JOB SHEET #12

L. Weld second pass with same electrode angle used for first pass and use some type of electrode manipulation (Figure 8)



Position for Second Bead

FIGURE 8

(NOTE: Check with instructor for specific instructions on electrode manipulation and location of second pass.)

M. If welding is interrupted, restrike arc 1/4" beyond end of bead; move back to bead and continue welding (Figure 9)

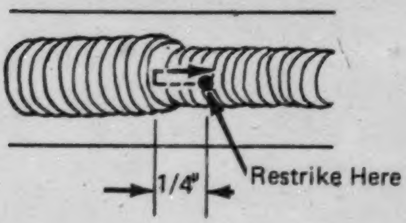


FIGURE 9

JOB SHEET #12

N. Weld third pass with electrode angled 5° down from horizontal with weld face crown 1/16" higher than plate surface and lapped 1/16" over bottom edge of groove (Figure 10)

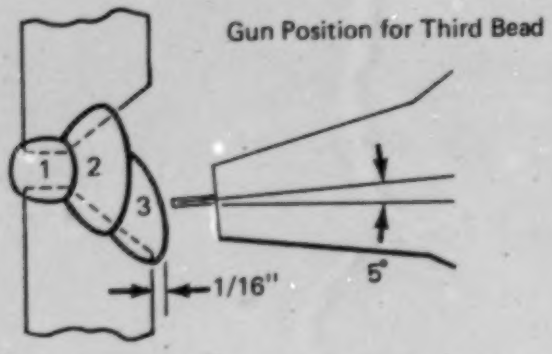


FIGURE 10

O. Deposit fourth pass with electrode angled up 5° from horizontal with weld bead overlapping top edge of groove 1/16" (Figure 11)

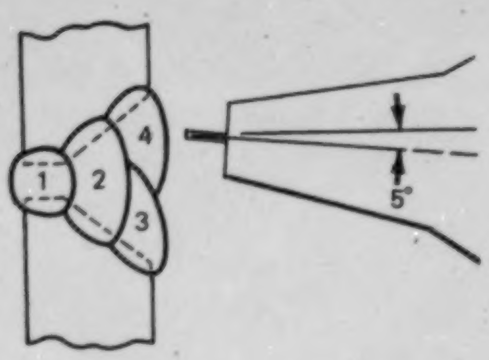


FIGURE 11

(NOTE: All passes require some type of electrode manipulation to control puddle with several techniques for laying filler passes. Consult your instructor for additional details.)

P. Upon completion of last pass, be sure to cool metal in still air and not in water which may cause unnecessary failure of coupon when tested

Q. See instructor for testing procedures

R. Cut coupons and prepare for root and face bend test

(NOTE: See SMAW, Unit II, Position Welding, Job Sheets 9 and 10 for this exercise.)

S. Turn in for instructor's inspection and approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #13--CONSTRUCT A SINGLE V-GROOVE BUTT JOINT IN THE VERTICAL DOWN POSITION WITH SHORT ARC FOR TEST

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas CO_2 or C-25 at 20-30 c.f.h. (25%--CO_2; 75% argon)
- C. Electrode filler wire--.035 diameter A.W.S. #E705-3
- D. Current setting--DCRP 120-130 amps (wire feed speed)
- E. Voltage setting 18-20 arc volts
- F. Material--2 pieces mild steel 3/8" x 5" x 6"
- G. Personal protective equipment

II. Procedure

- A. Adjust power supply and wire feeder to correct voltage and amperage
- B. Set shielding gas flow rate 20-30 c.f.h.
- C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

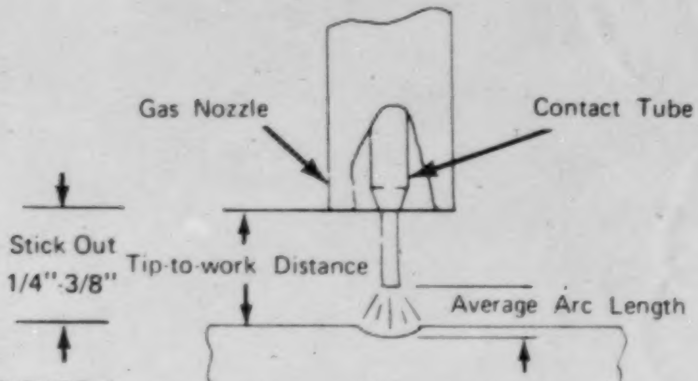
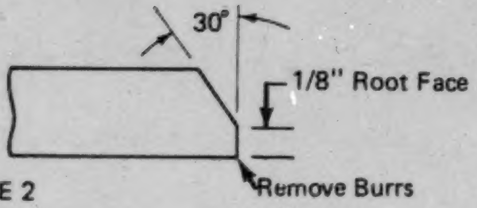


FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #13

D. Prepare metal by beveling one long side of each plate (Figure 2)


30°
1/8" Root Face
Remove Burrs

Grind 1/8" Root Face

Remove Burrs on Back Side of Plate

FIGURE 2

E. Position material to form a butt joint and tack weld (Figure 3)

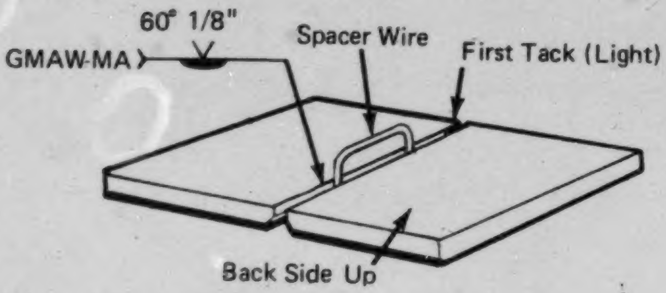

60° 1/8"
GMAW-MA
Spacer Wire
First Tack (Light)
Back Side Up

FIGURE 3

(NOTE: Separate plates with 1/8" U-shaped wire spacer. Deposit light tack at one end, then deposit 1/4" tack at other end removing 1/8" wire immediately.)

F. Grind tacks with right angle grinder to a minimum thickness of 1/16" (Figure 4)

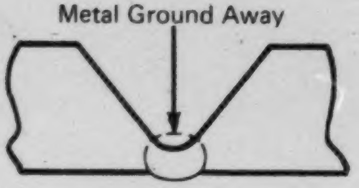

Metal Ground Away

FIGURE 4

(NOTE: Grind sides to a smooth, round contour. Grind ends to a sharp, feathered edge.)

JOB SHEET #13

G. Place metal in vertical position for welding (Figure 5)

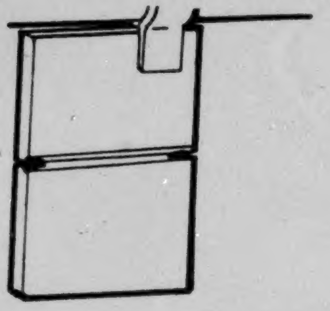
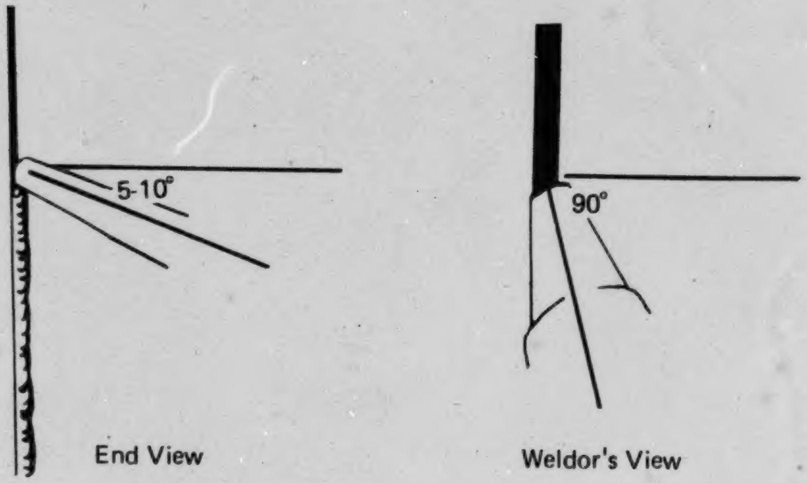


FIGURE 5

H. Position electrode straight into joint (90°) and angled 5°-10° upward (Figure 6)



End View

Weldor's View

FIGURE 6

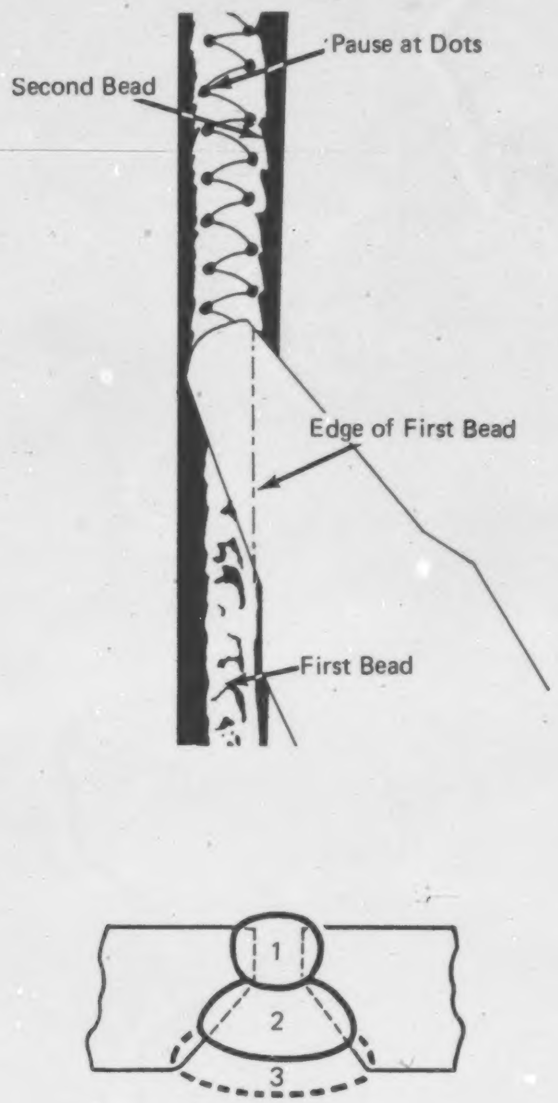
I. For root pass, position electrode 1/2" to 3/4" down from top of plate, start arc, rapidly move electrode to top of joint, and weld downward; use a weaving technique pausing on sides of joint to fill crater and keeping electrode in leading edge of puddle

(CAUTION: Avoid moving wire past the leading edge of puddle or wire will plunge through root opening.)

(NOTE: See instructor for detailed instructions on electrode angle and manipulation for all beads.)

JOB SHEET #13

J. For second pass, use same technique as used on root pass but make wider weaves pausing at edges of first bead (Figure 7)


Pause at Dots
Second Bead
Edge of First Bead
First Bead
1
2
3

Bead Sequence

FIGURE 7

(NOTE: Travel at speed to fill joint approximately three-fourths full.)

JOB SHEET #13

K. For third pass, (cover pass) use same technique as second pass, but use wider weave motion to produce a weld bead slightly wider than width of joint (approximately 1/16" wider) (Figure 8)

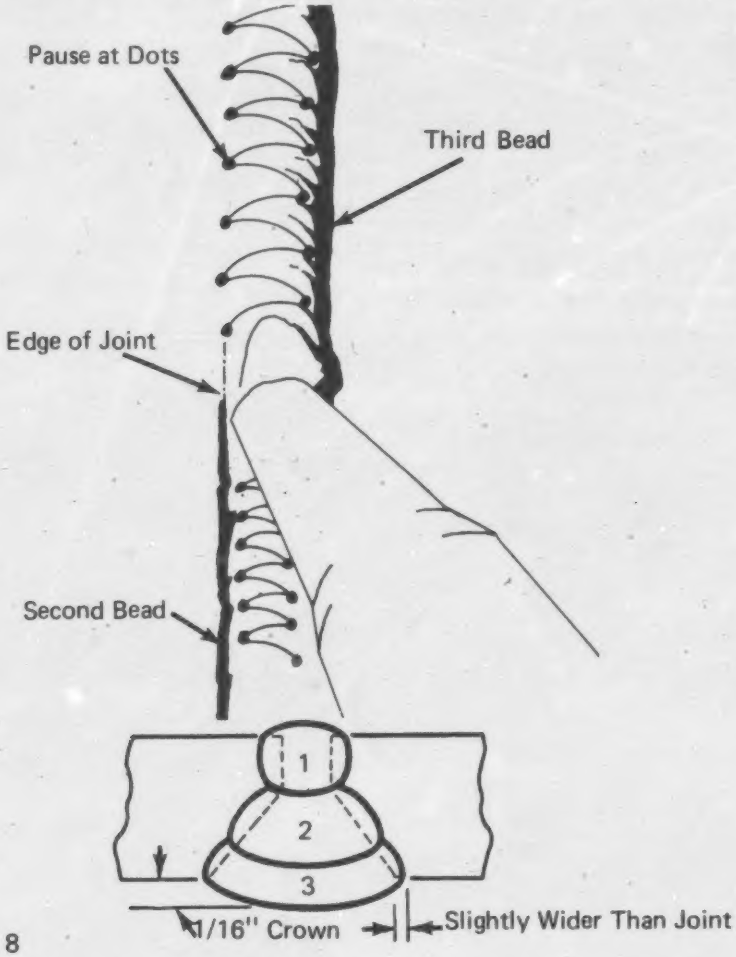

Pause at Dots
Third Bead
Edge of Joint
Second Bead
1
2
3
1/16" Crown
Slightly Wider Than Joint

FIGURE 8

L. Upon completion of cover pass, air cool metal; do not cool bead in water as it may cause weld to fail when tested

M. See instructor for testing procedures

N. Cut coupons and prepare for root and face bend tests

(NOTE: See SMAW, Unit II, Position Welding, Job Sheets 9 and 10 for this exercise.)

O. Turn in for instructor's inspection and approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #14--CONSTRUCT A SINGLE V-GROOVE BUTT JOINT IN THE VERTICAL UP POSITION WITH SHORT ARC FOR TEST

I. Equipment and materials needed

   A. GMAW power supply, wire feeder, and air cooled gun for short arc application

   B. Shielding gas CO_2 or C-25 at 20-30 c.f.h. (25%--CO_2; 75% argon)

   C. Electrode filler wire--.035 diameter A.W.S. #E705-3

   D. Current setting--DCRP 120-130 amps (wire feed speed)

   E. Voltage setting 18-20 arc volts

   F. Material--2 pieces mild steel 3/8" x 3" x 6"

   G. Personal protective equipment

II. Procedure

   A. Adjust power supply and wire feeder to correct voltage and amperage

   B. Set shielding gas flow rate 15-20 c.f.h.

   C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

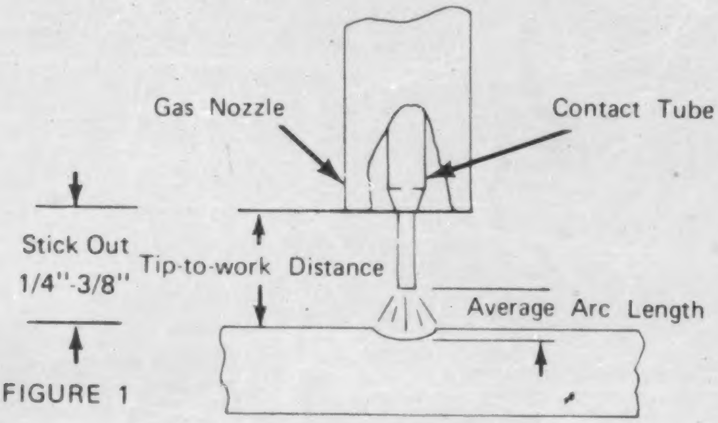
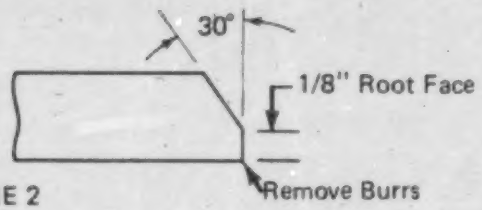


FIGURE 1

(NOTE: Some types of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #14

D. Prepare metal by beveling one long side of each plate (Figure 2)


30°
1/8" Root Face
Remove Burrs

Grind 1/8" Root Face

Remove Burrs
on Back Side of Plate

FIGURE 2

E. Position material to form a butt joint and tack weld (Figure 3)

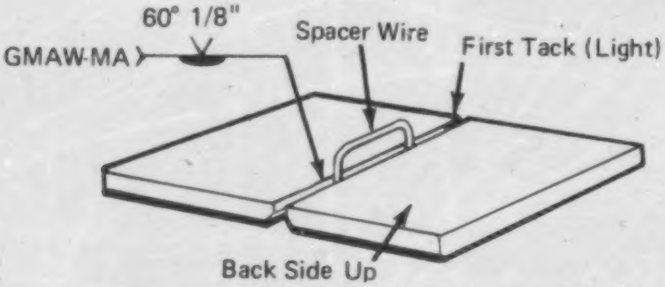

60° 1/8"
GMAW-MA
Spacer Wire
First Tack (Light)
Back Side Up

FIGURE 3

(NOTE: Separate plates with 1/8" U-shaped wire spacer. Deposit light tack at one end, then deposit 1/4" tack at other end removing 1/8" wire immediately.)

F. Grind tacks with right angle grinder to a minimum thickness of 1/16" (Figure 4)

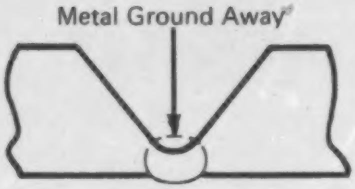

Metal Ground Away

FIGURE 4

(NOTE: Grind sides to a smooth, round contour. Grind ends to a sharp, feathered edge.)

JOB SHEET #14

G. Place metal in vertical position for welding (Figure 5)

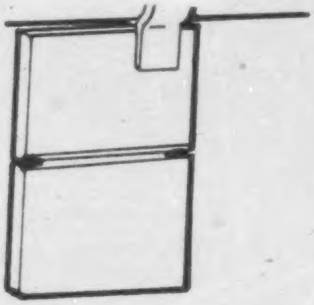


FIGURE 5

H. Position electrode straight into joint (90°) and angled 5°-10° upward (Figure 6)

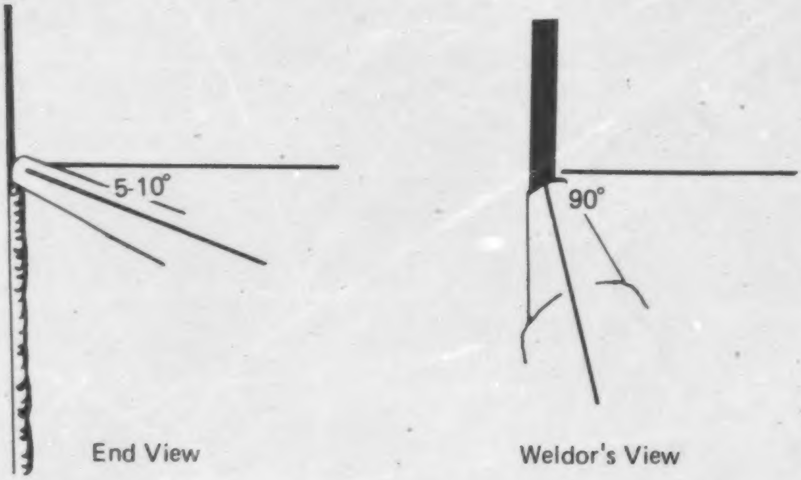


FIGURE 6

I. For root pass, position electrode 1/2" to 3/4" up from bottom of joint, start arc, move to bottom of joint, and begin welding upward; use some type of U-shaped weave motion pausing on the sides of joint to fill the crater and to prevent undercut; also, be careful to keep electrode tip in leading edge of puddle

(NOTE: See instructor for specific details on electrode angle and manipulation for all beads.)

(CAUTION: Avoid moving electrode wire past the leading edge of puddle or wire will plunge through root opening.)

JOB SHEET #14

J. For second pass, use same technique with wider weave motion, pausing at edge of previous bead long enough to fill joint (Figure 7)

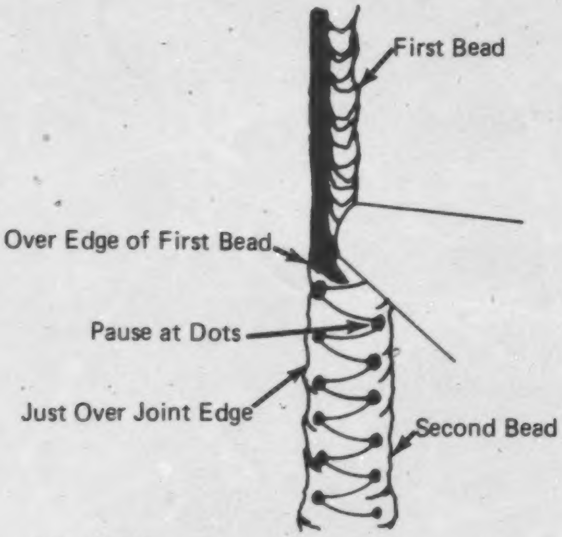

First Bead
Over Edge of First Bead
Pause at Dots
Just Over Joint Edge
Second Bead

FIGURE 7

(NOTE: Cover pass (second bead) should extend over width of joint about 1/16" on each side.)

K. Upon completion of cover pass, air cool metal; do not cool in water as it may cause weld to fail when tested

L. See instructor for testing procedures

M. Cut coupons and prepare for root and face bend tests

(NOTE: See SMAW, Unit II, Position Welding, Job Sheets 9 and 10 for testing procedures.)

N. Turn in for instructor's inspection and approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #15--CONSTRUCT A SINGLE V-GROOVE BUTT JOINT IN THE OVERHEAD POSITION WITH SHORT ARC FOR TEST

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas CO_2 or C-25 at 20-30 c.f.h. (25%--CO_2; 75% argon)

C. Electrode filler wire--.035 diameter A.W.S. #E705-3

D. Current setting--DCRP 120-130 amps (wire feed speed)

E. Voltage setting 18-20 arc volts

F. Material--2 pieces mild steel 3/8" x 3" x 6"

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 15-20 c.f.h.

C. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

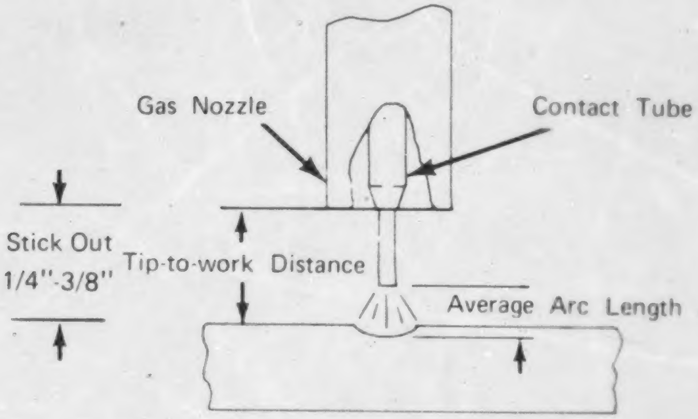
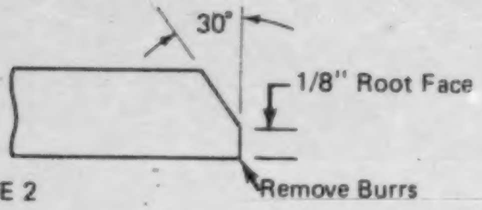


FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #15

D. Prepare metal by beveling one long side of each plate (Figure 2)


30°
1/8" Root Face
Remove Burrs

Grind 1/8" Root Face

Remove Burrs
on Back Side of Plate

FIGURE 2

E. Position material to form a butt joint and tack weld (Figure 3)

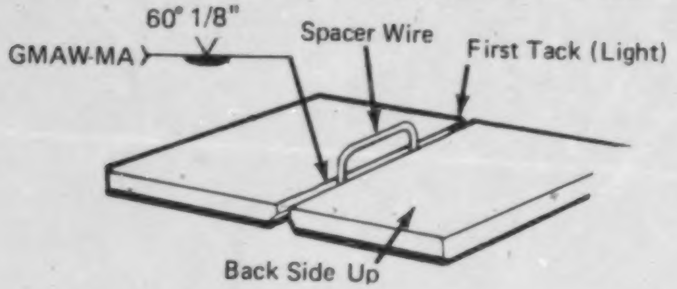

60° 1/8"
GMAW-MA
Spacer Wire
First Tack (Light)
Back Side Up

FIGURE 3

(NOTE: Deposite light tack at one end; then, deposit 1/4" tack at other end removing 1/8" wire immediately.)

F. Grind tack with right angle grinder to a minimum (1/16") thickness (Figure 4)

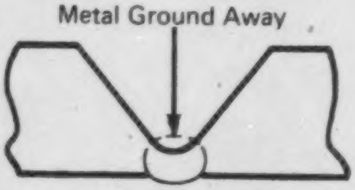

Metal Ground Away

FIGURE 4

(NOTE: Grind sides to a smooth round contour. Grind ends to a sharp, feathered edge.)

G. Place metal in overhead position (Figure 5)

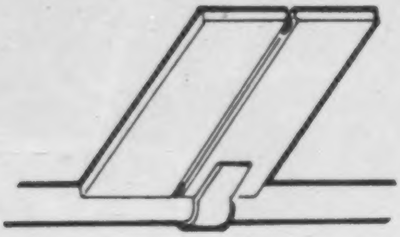


FIGURE 5

JOB SHEET #15

H. Position electrode straight into joint and angled 5°-10° in direction of travel (Figure 6)

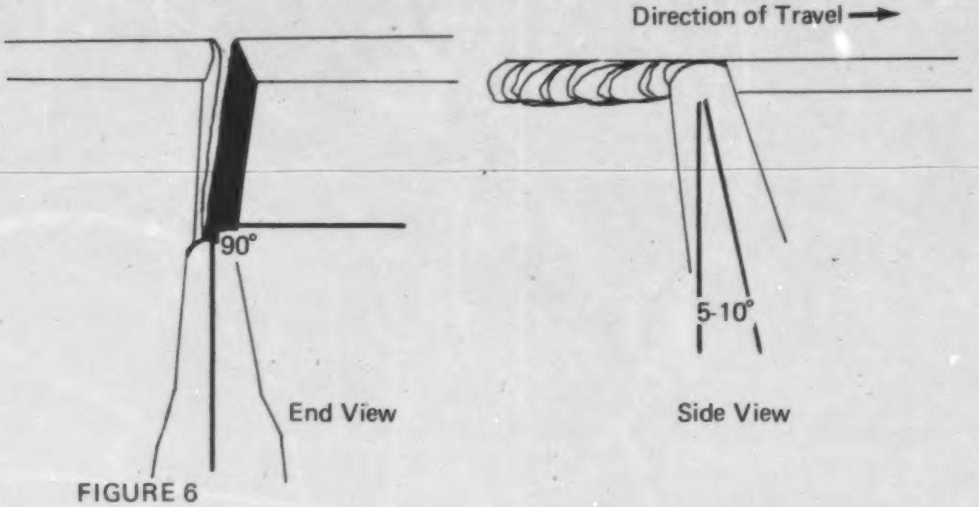


FIGURE 6

I. For root pass, start arc 1/2" to 3/4" down from end; begin welding with a slight weaving motion keeping electrode in leading edge of puddle and traveling at a speed to fill joint half full (Figure 7)

(NOTE: Bead should have a 1/16" crown.)

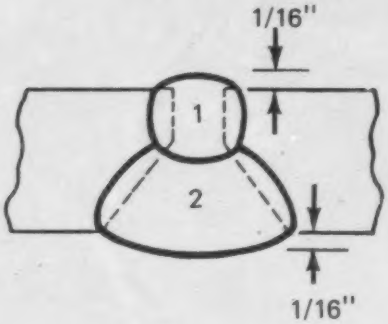


FIGURE 7

(NOTE: See instructor for specific details on electrode angle and manipulation for all beads.)

(CAUTION: Avoid moving electrode past leading edge of puddle or wire will plunge through root opening.)

JOB SHEET #15

J. For second pass, (cover pass) hold gun so electrode wire has no forward angle and use a wider weaving motion pausing at sides of joint; overlap edge 1/16" with a slight crown on cover pass (Figure 8)

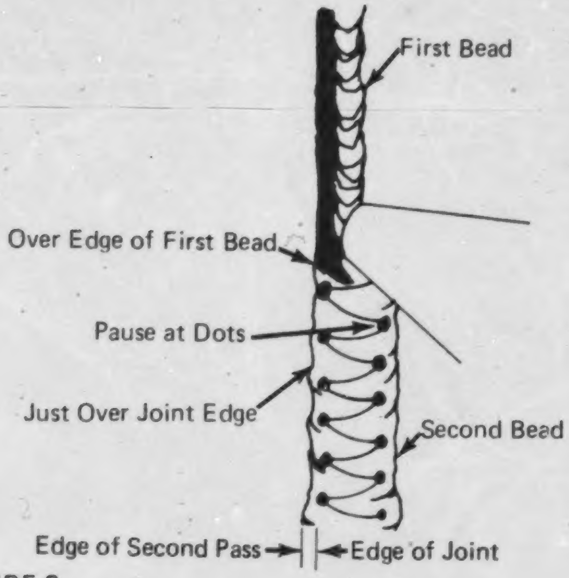

First Bead
Over Edge of First Bead
Pause at Dots
Just Over Joint Edge
Second Bead
Edge of Second Pass
Edge of Joint

FIGURE 8

(NOTE: Maintain correct stick out of 1/4" to 3/8".)

K. Upon completion of cover pass, air cool metal; do not cool in water as it may cause weld to fail when tested

L. See instructor for testing procedures

M. Cut coupons and prepare for root and face bend tests

(NOTE: See SMAW, Unit II, Position Welding, Job Sheets 9 and 10 for testing procedures.)

N. Turn in for instructor's inspection and approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #16--CONSTRUCT A MULTIPLE PASS LAP JOINT FILLET WELD IN THE HORIZONTAL POSITION WITH SPRAY ARC

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for spray arc application

B. Shielding gas Argon-Oxygen at 30-40 c.f.h. (95% argon; 5% oxygen)

C. Electrode filler wire--1/16" diameter A.W.S. #E705-3

D. Current setting--DCRP 250-300 amps (wire feed speed)

E. Voltage setting 25-30 arc volts

F. Material--2 pieces mild steel 1" x 2 1/2" x 8"

(NOTE: Various sizes of metal can be substituted here.)

G. Personal protective equipment

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

B. Set shielding gas flow rate 30-40 c.f.h.

C. Adjust stick out 3/4" to 1" and clean nozzle if needed (Figure 1)

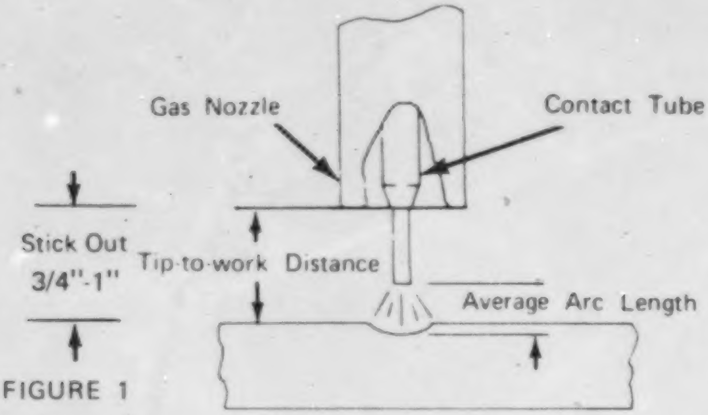


FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

JOB SHEET #16

D. Position metal to form a lap joint and tack weld (Figure 2)

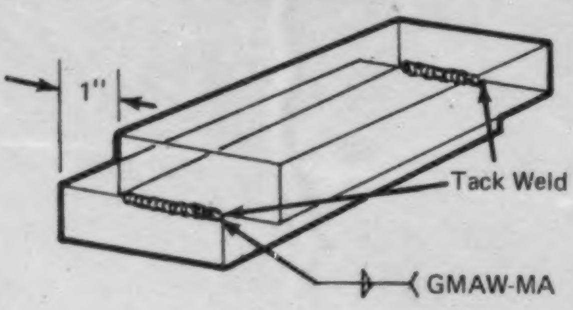


FIGURE 2

E. Place metal in horizontal position for welding

F. Position electrode (gun) at 45° side angle and angled 5° to 10° in direction of travel

(NOTE: Electrode angle will change slightly for each bead. See instructor for detailed instructions.)

G. Travel from left to right at a speed to produce welds with 5/16" legs

H. Start arc 1" from left end of joint; then move back to end of joint and begin welding first bead being careful to maintain the 3/4" to 1" stick out

(NOTE: To prevent undue distortion, run one bead on opposite side before depositing remainder of beads on first side.) (Figure 3)

I. Continue running beads until joint is filled using sequence shown in Figure 3

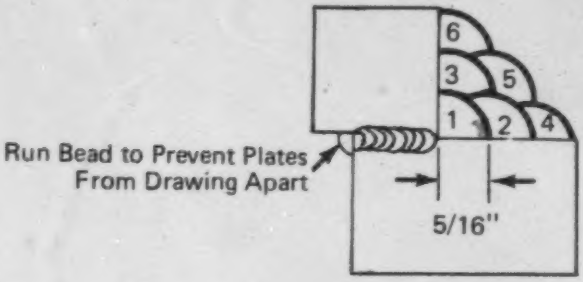


FIGURE 3

Bead Sequence

End View

(NOTE: See instructor for specific instructions on electrode manipulation, travel speed, stick out, and bead sequence.)

JOB SHEET #16

J. Cool metal, turn metal over, and weld other side using same procedure

K. Inspect welded joint for correct bead size, placement, smoothness, and undercutting

(NOTE: Spray arc should produce smooth beads with no spatter in the flat and horizontal positions only. Should any bead contain porosity, it must be cut or ground out completely before next pass is run. Never weld over porosity.)

L. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #17--CONSTRUCT A MULTIPLE PASS V-JOINT FILLET WELD IN THE FLAT POSITION WITH FLUX CORED WIRE

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for flux cored application

B. Shielding gas CO_2 at 35-40 c.f.h.

C. Electrode filler wire--1/16" diameter A.W.S. #E70T-2

D. Current setting--DCRP 175-300 amps (wire feed speed)

E. Voltage setting 25-30 arc volts

F. Material--2 pieces mild steel 1" x 2 1/2" x 8"

(NOTE: Several sizes of metal can be substituted here.)

G. Personal protective equipment

(CAUTION: Adequate ventilation is absolutely necessary due to excessive smoke produced with flux cored process.)

H. Steel wire brush

I. Slag hammer

II. Procedure

A. Adjust power supply and wire feeder to correct voltage and amperage

(NOTE: Too much current and/or voltage will cause undercutting, spatter, poor bead shape, and lack of control. An extreme excess of current causes end of electrode filler wire to strike or stub out weld joint. This causes uneven, high crown cold lapped beads.)

B. Set shielding gas flow rate 35-40 c.f.h.

JOB SHEET #17

C. Adjust stick out 3/4" to 1" and clean nozzle if needed (Figure 1)

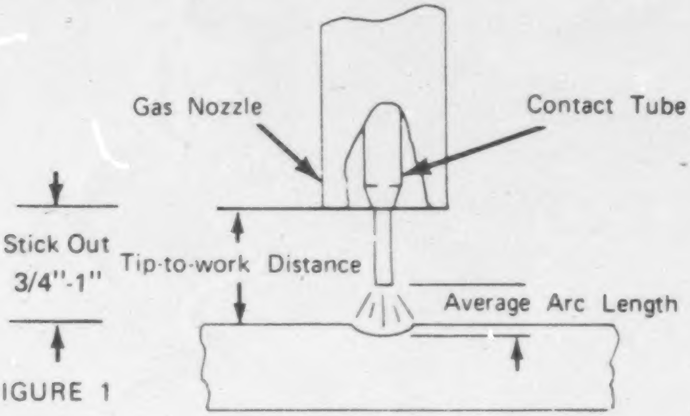

Gas Nozzle
Contact Tube
Stick Out
3/4"-1"
Tip-to-work Distance
Average Arc Length

FIGURE 1

(NOTE: Keep nozzle clean. Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

D. Position metal to form a V-joint and tack weld; then run a bead on back side of joint to prevent distortion (Figure 2)

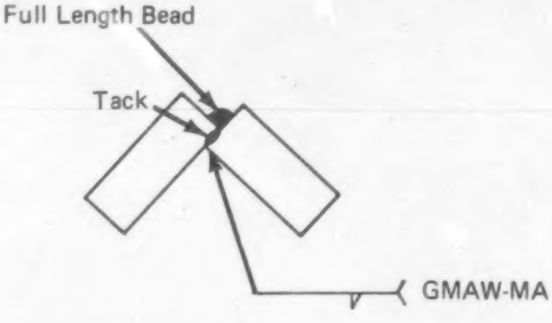

Full Length Bead
Tack
GMAW-MA

FIGURE 2

JOB SHEET #17

E. Place metal in the flat position for welding (Figure 3)

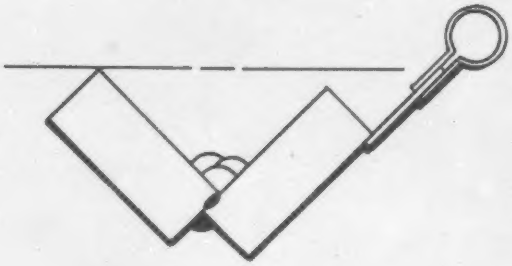


FIGURE 3

F. Position electrode straight into joint and angled 5°-10° degrees in direction of travel

(NOTE: Electrode angle will change slightly for each bead. See instructor for detailed instructions.)

G. Travel from left to right

H. Start arc 1" from left end of joint; then move back to end of joint and begin welding first stringer bead; be careful to maintain correct stick out and to center wire in middle of joint using some type of manipulation

(NOTE: Always remove slag before running next bead.)

I. Run three stringer beads overlapping each as shown in Figure 4

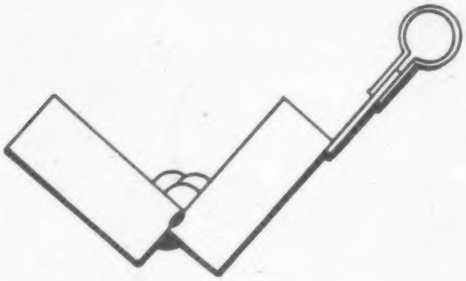


FIGURE 4

(NOTE: Keep metal cool.)

JOB SHEET #17

J. Fill remainder of joint with three weave beads (Figure 5)

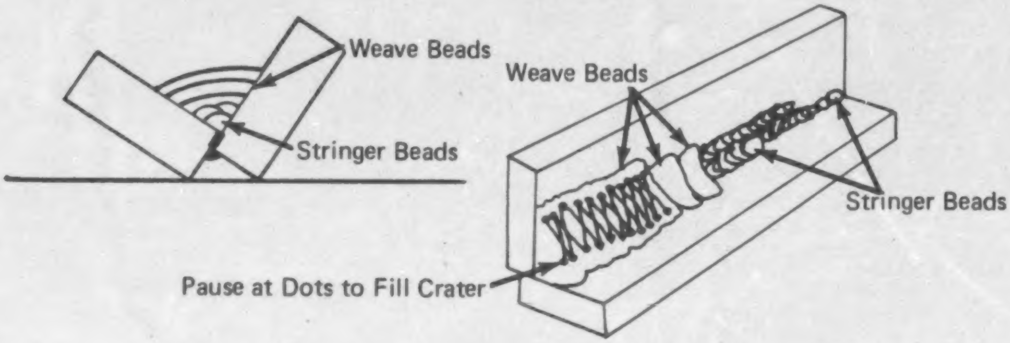

Weave Beads
Stringer Beads
Weave Beads
Stringer Beads
Pause at Dots to Fill Crater

FIGURE 5

(NOTE: See instructor for instructions on electrode manipulation and travel speeds on all three weave beads.)

K. Joint can be welded using stringer beads only (Figure 6)

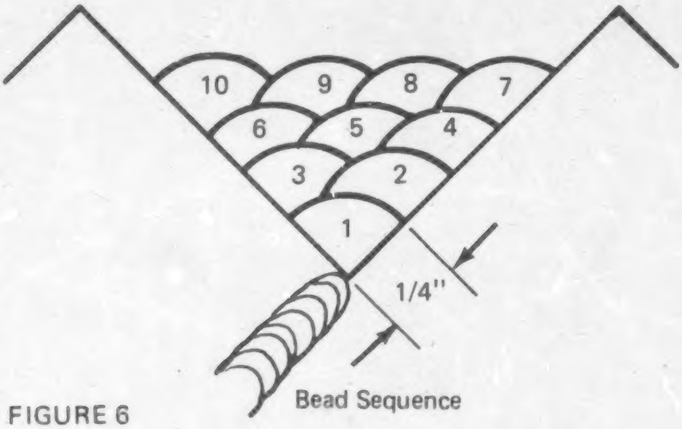

10
9
8
7
6
5
4
3
2
1
1/4"
Bead Sequence

FIGURE 6

(NOTE: See instructor before using this method.)

L. Inspect weld for correct bead size, placement, smoothness, undercutting, and slag inclusions

M. Remove all slag before turning in

N. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #18--CONSTRUCT A T-JOINT FILLET WELD ON ALUMINUM PLATE IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Equipment and materials needed

   A. GMAW power supply, wire feeder, and air cooled gun for short arc application

      (NOTE: A portable gun with built in wire feeder is best for small wire diameters.)

   B. Shielding gas--Argon at 25-35 c.f.h.

   C. Electrode filler wire--.030 diameter 4043 or 5356 most common

   D. Current setting--DCRP 120-150 amps (wire feed speed)

   E. Voltage setting 20-25 arc volts

   F. Material--2 pieces aluminum 1/4" x 3" x 6"

   G. Personal protective equipment

   H. Stainless steel wire brush

II. Procedure

   A. Clean metal of dirt, grease, and oxides

   B. Adjust power supply and wire feeder to correct voltage and amperage

      (NOTE: Wire feed control is adjusted at the gun if a portable gun is used.)

   C. Set shielding gas flow rate 25-35 c.f.h.

JOB SHEET #18

D. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

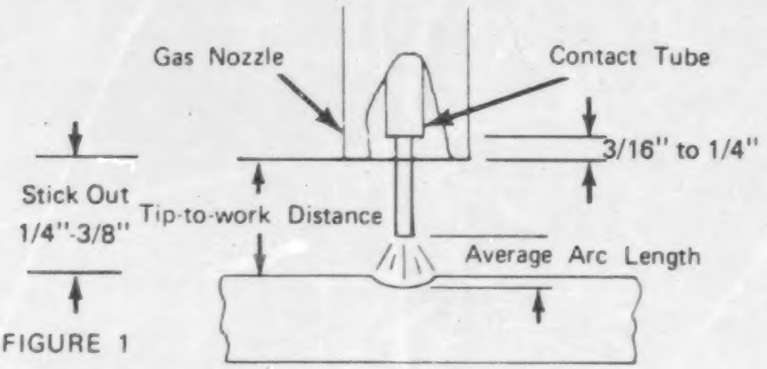

Gas Nozzle
Contact Tube
3/16" to 1/4"
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 1

(NOTE: Contact tip should be 3/16" to 1/4" in from nozzle end. Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Prepare metal by leveling one T-joint and make two 1/2" tacks (Figure 2)

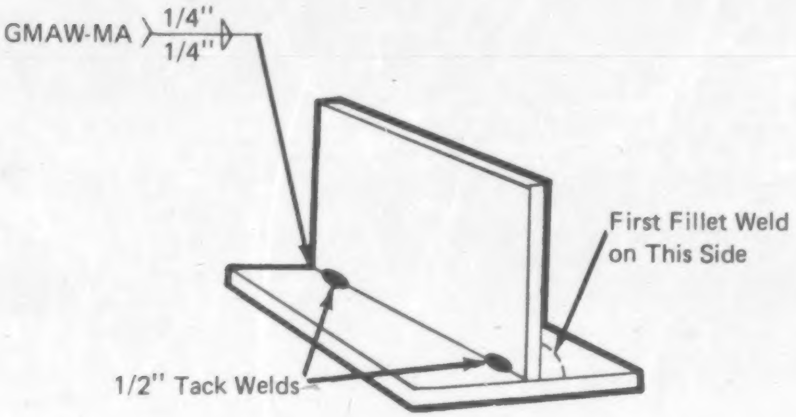

GMAW-MA
1/4"
1/4"
First Fillet Weld on This Side
1/2" Tack Welds

FIGURE 2

F. Place metal in the horizontal position for welding

JOB SHEET #18

G. Position gun nozzle at a 45° degree angle from vertical plate and 15° back from direction of travel welding from right to left (Figure 3)

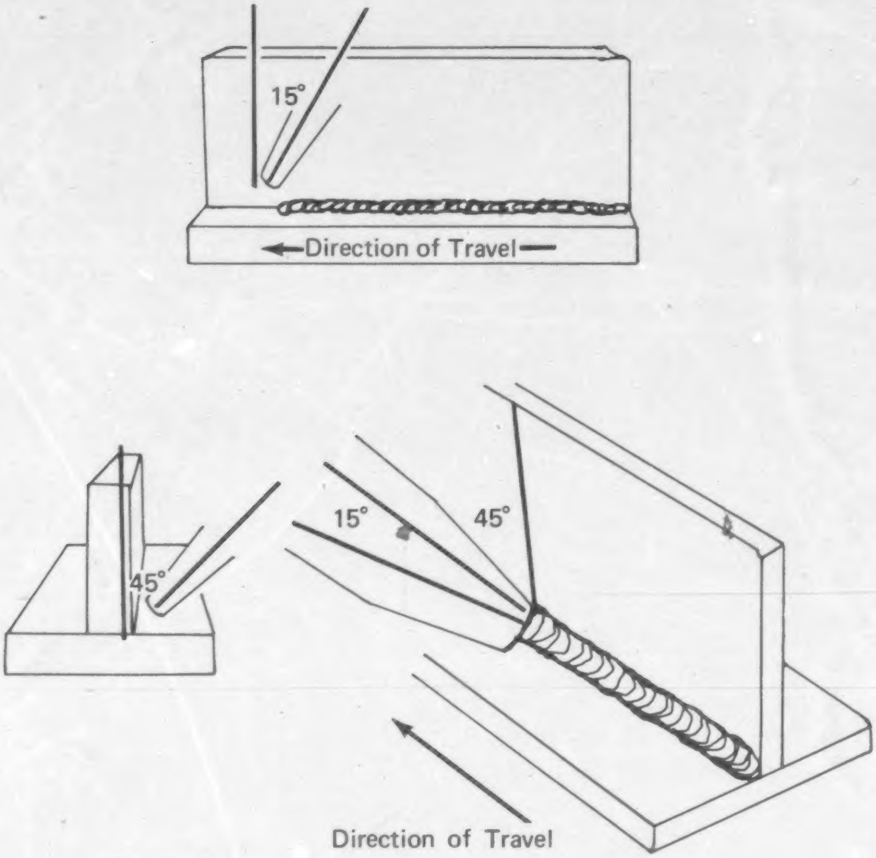


FIGURE 3

(NOTE: Run first bead on side opposite tack welds. Electrode angle will change slightly with next two beads. See instructor for detailed instructions.)

H. Start arc 1/2"-3/4" from right end of joint; then move electrode back to right end and begin welding using some type of electrode manipulation and reversing travel at end of joint for 1/4" to fill crater; release gun trigger

(CAUTION: Care should be taken to have wire in motion as it strikes joint to avoid burn back to contact tip. This condition is usually caused by excessive voltage adjustment.)

JOB SHEET #18

I. Run three beads on each side overlapping (Figure 4)

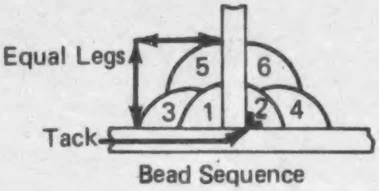

Equal Legs
5
6
3
1
2
4
Tack
Bead Sequence

FIGURE 4

(NOTE: Keep metal cool.)

J. Inspect weld for correct bead size, placement, and smoothness with even ripple and undercutting

K. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #19--CONSTRUCT A MULTIPLE PASS T-JOINT FILLET WELD ON ALUMINUM PLATE IN THE VERTICAL UP POSITION WITH SHORT ARC

I. Equipment and materials needed

- A. GMAW power supply, wire feeder, and air cooled gun for short arc application
- B. Shielding gas--Argon at 25-35 cfh
- C. Electrode filler wire--.030 diameter 4043 or 5356 most common
- D. Current setting--DCRP 120-150 amps (wire feed speed)
- E. Voltage setting 20-25 arc volts
- F. Material--2 pieces aluminum 1/4" x 3" x 6"
- G. Personal protective equipment
- H. Stainless steel wire brush

II. Procedure

- A. Clean metal of dirt, grease, and oxides
- B. Adjust power supply and wire feeder to correct voltage and amperage

  (NOTE: Wire feed control is adjusted at the gun if a portable gun is used.)
- C. Set shielding gas flow rate 25-35 c.f.h.

JOB SHEET #19

D. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

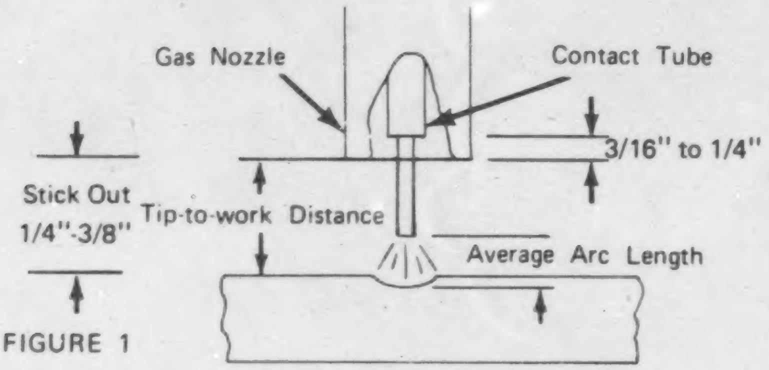

Gas Nozzle
Contact Tube
3/16" to 1/4"
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 1

(NOTE: Contact tip should be 3/16" + 1/4" in from nozzle end. Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Position metal to form a T-joint and make two 1/2" tacks (Figure 2)

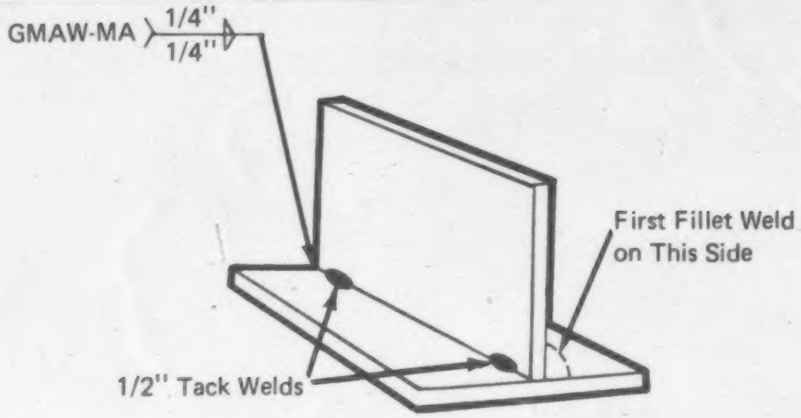

GMAW-MA
1/4"
1/4"
First Fillet Weld
on This Side
1/2" Tack Welds

FIGURE 2

F. Place metal in the vertical position for welding

JOB SHEET #19

G. Position gun nozzle at a 45° degree angle from sides of joint (centered) and 15°-20° degrees up from horizontal (Figure 3)

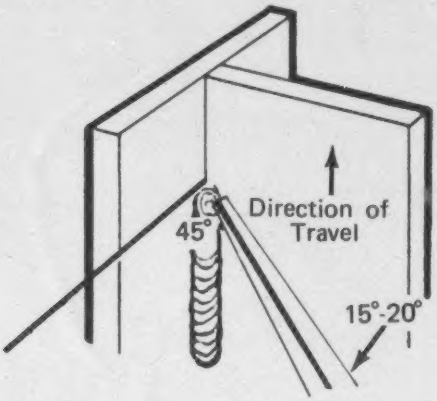


FIGURE 3

(NOTE: Electrode angle will change slightly with next two stringers and weave bead. See instructor for detailed instructions.)

H. Start arc 1/2" to 3/4" from bottom of joint; then move electrode to bottom and start welding upward reversing travel at end of joint 1/4" to fill crater; release trigger

(NOTE: Some form of electrode manipulation such as weaving will be helpful in forming beads.)

(CAUTION: Care should be taken to have wire in motion as it strikes joint to avoid burn back to contact tip. This condition is usually caused by excessive voltage.)

I. Run three stringer beads on first side and one stringer and one weave on the other side (Figure 4)

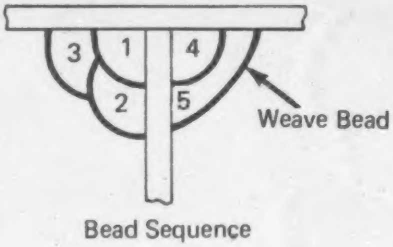


FIGURE 4

(NOTE: Final bead (#5) will be a weave. Pause at edges of bead #4 long enough to fill crater. Keep metal cool.)

JOB SHEET #19

J. Inspect welds for correct bead size, placement, and smoothness with even ripple, and undercutting

K. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #20--CONSTRUCT A T-JOINT FILLET WELD ON STAINLESS STEEL IN THE HORIZONTAL POSITION WITH SHORT ARC

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas C-25 at 20 c.f.h. (Preferred gas: 90% helium, 7.5% argon, and 2.5% carbon dioxide)

C. Electrode filler wire--.035 diameter

(NOTE: Filler wire should match or exceed in quality the type of stainless being welded.)

D. Current setting--DCRP 75-100 amps (wire feed speed)

E. Voltage setting 19-20 arc volts

F. Material--2 pieces stainless steel 1/8" x 3" x 6"

G. Personal protective equipment

H. Stainless steel wire brush

II. Procedure

A. Clean metal of all grease and dirt as well as glue sometimes left from protective paper covering

B. Adjust power supply and wire feeder to correct voltage and amperage

(NOTE: Adjust to lowest practical amps and volts being careful to adjust voltage to correct setting. One volt over or under will cause a bad weld.)

C. Set shielding gas flow rate 20 c.f.h.

JOB SHEET #20

D. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

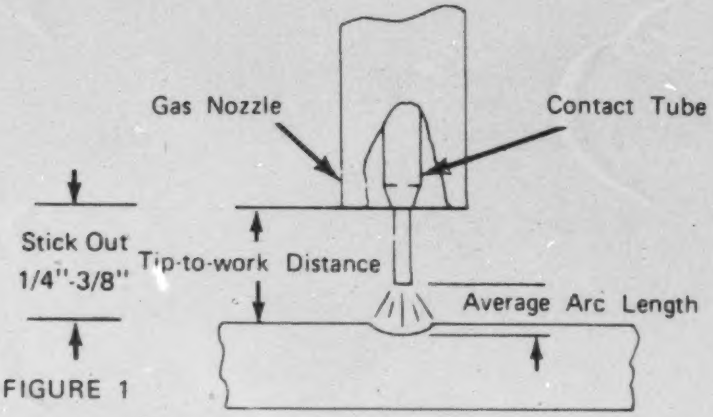

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Position metal to form a T-joint and tack on each end (Figure 2)

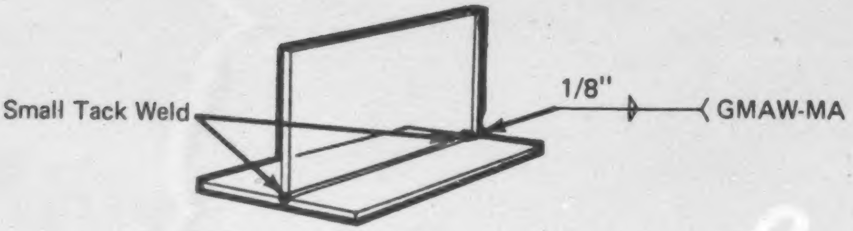

Small Tack Weld
1/8"
GMAW-MA

FIGURE 2

F. Place metal in horizontal position for welding

JOB SHEET #20

G. Position gun nozzle at 45° from bottom plate and angled 5°-10° in direction of travel (Figure 3)

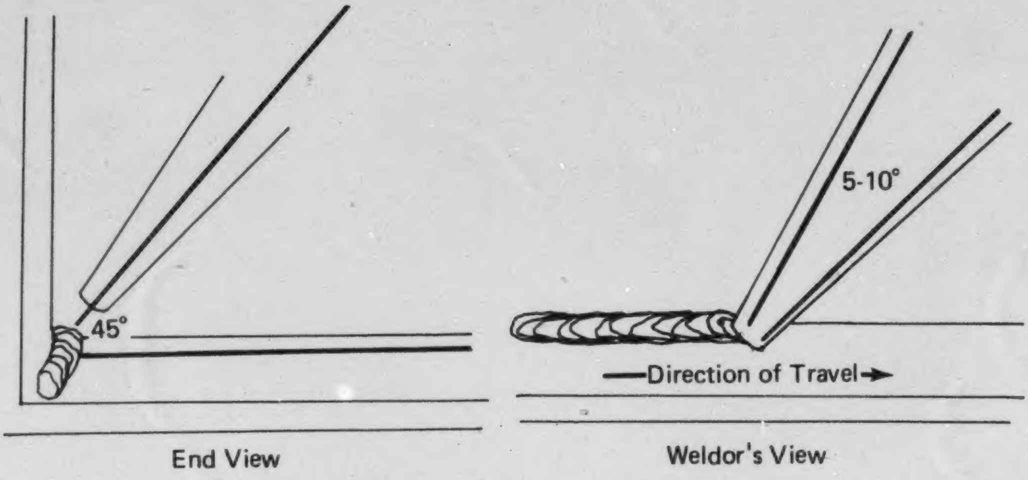


FIGURE 3

H. Start arc 1/2" to 3/4" from left end of joint; then move to left end of joint and start welding reversing travel 1/4" at end of joint to fill crater

(NOTE: Keep electrode manipulation to a minimum.)

I. Run one stringer bead on each side

(NOTE: Welder should use stringers rather than weaves to minimize heat input into base metal.)

J. Travel smoothly from left to right centering wire in middle of joint depositing a bead with 1/8" leg size

(NOTE: Weld as fast as possible to minimize heat input into metal.)

K. Inspect weld for correct bead size, placement, even ripple, and undercutting as well as crater cracks and spatter

L. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

JOB SHEET #21--CONSTRUCT A SQUARE GROOVE BUTT WELD ON STAINLESS STEEL IN THE FLAT POSITION WITH SHORT ARC

I. Equipment and materials needed

A. GMAW power supply, wire feeder, and air cooled gun for short arc application

B. Shielding gas C-25 at 20 c.f.h. (Preferred gas: 90% helium, 7.5% argon, and 2.5% carbon dioxide)

C. Electrode filler wire--.035 diameter

(NOTE: Filler wire should match or exceed in quality the type of stainless being welded.)

D. Current setting--DCRP 75-200 amps (wire feed speed)

E. Voltage setting 19-21 arc volts

F. Material--2 pieces stainless steel 1/8" x 3" x 6"

G. Personal protective equipment

H. Stainless steel wire brush

II. Procedure

A. Clean metal of all grease and dirt as well as glue sometimes left from protective paper covering

B Adjust power supply and wire feeder to correct voltage and amperage

(NOTE: Adjust to lowest practical amps and volts being careful to adjust voltage to correct setting. One volt over or under will cause a bad weld.)

C. Set shielding gas flow rate 20 c.f.h.

JOB SHEET #21

D. Adjust stick out 1/4" to 3/8" and clean nozzle if needed (Figure 1)

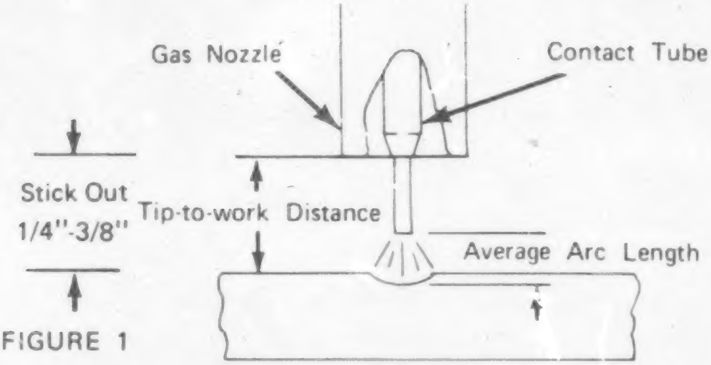

Gas Nozzle
Contact Tube
Stick Out
1/4"-3/8"
Tip-to-work Distance
Average Arc Length

FIGURE 1

(NOTE: Some type of anti-spatter compound applied to nozzle and contact tip makes cleaning much easier.)

E. Position metal to form a butt joint gap 1/16" and tack on each end placing scrap pieces under weld metal to hold off table (Figure 2)

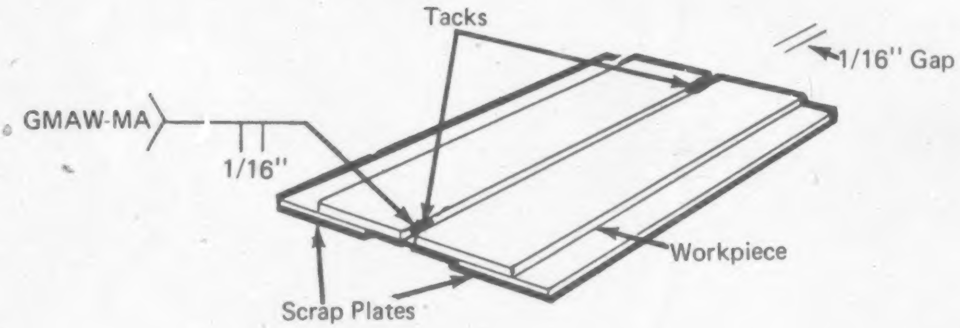

Tacks
1/16" Gap
GMAW-MA
1/16"
Workpiece
Scrap Plates

FIGURE 2

JOB SHEET #21

F. Position gun nozzle at 90° angle to both pieces of metal and angled 5°-10° in direction of travel with electrode wire centered in middle of joint (Figure 3)

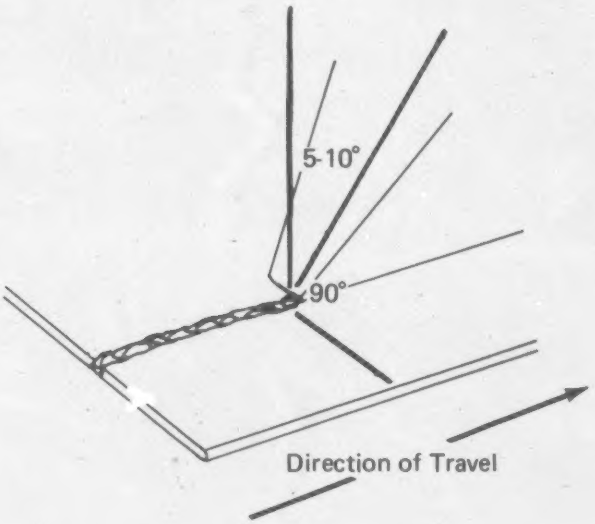


FIGURE 3

(NOTE: Travel from left to right.)

G. Start arc 1" from left end of joint; then move to left end of joint at a speed to produce a weld bead 1/4" wide with complete penetration; at end of joint, reverse travel to fill crater

(NOTE: Should bead become too large and penetration too great, increase travel speed. If burn-through occurs, reduce current and/or voltage slightly or increase travel speed.)

H. Inspect weld for correct bead size, even ripples, undercutting, complete penetration, weld cracks, and spatter

I. Turn in for instructor's approval

GAS METAL ARC WELDING
UNIT II

TEST

1. Match the following terms with their definitions.

_____a. The heat generated by the flow of current through the gap between the end of the wire and the workpiece; voltage appears across this gap and varies in the same direction as the length of the arc

_____b. A welding process performed in GMAW usually done on thicker metal using larger diameter wires and a shielding gas mixture of argon with 1-5% oxygen done in the flat and horizontal positions only

_____c. Will usually be DCRP with the welding wire positive (+) and the work negative (-)

_____d. An arc welding process in which a consumable bare electrode is fed into a weld joint at a controlled rate while a continuous blanket of gas, inert or otherwise, shields the weld zone from contamination by the atmosphere

_____e. Abbreviation for flux cored arc welding; a form of GMAW performed with a cored consumable electrode (flux inside the wire)

_____f. A welding application of the GMAW process where low currents, low voltages, and small diameter wires are used to weld on thin to heavy metals in all positions

_____g. Voltage indicated by a volt meter on GMAW power supply when machine is welding

1. Slope
2. Arc voltage
3. Slope control
4. Ferrous
5. Inductance
6. Open circuit voltage
7. Non-ferrous
8. Stick out
9. Short circuiting transfer (Short arc)
10. FCAW
11. Welding voltage
12. Whiskers
13. Welding current
14. Gas metal arc welding (GMAW)
15. Spray transfer (Spray arc)
16. Shielding gases

_____h. Any metal containing iron such as mild steel or stainless steel

_____i. Any metal that contains no iron such as aluminum or magnesuim

_____j. The slant of the volts versus amps curve, generally referred to as volts change per 100 amps

_____k. A control on the power supply that regulates the amount of pinch force available on the welding wire thereby controlling spatter or the pinch effect

_____l. Controls the rate of rise of current without controlling the final amount of current available

_____m. The distance from the contact tip of the gun to the end of the electrode

_____n. Short lengths of welding wire that feed through the root gap of a grooved joint and extend out from the root of the weld in all directions

_____o. Voltage indicated by volt meter on GMAW power supply when machine is running but not welding

_____p. Gases, inert or otherwise, used to displace the air around the arc to prevent contamination by oxygen, nitrogen, or hydrogen in the atmosphere

2. List six advantages of the GMAW process.

   a.

   b.

   c.

   d.

e.

f.

3. Identify the major parts of the GMAW equipment.

a.

b.

c.

d.

e.

f.

g.

h.

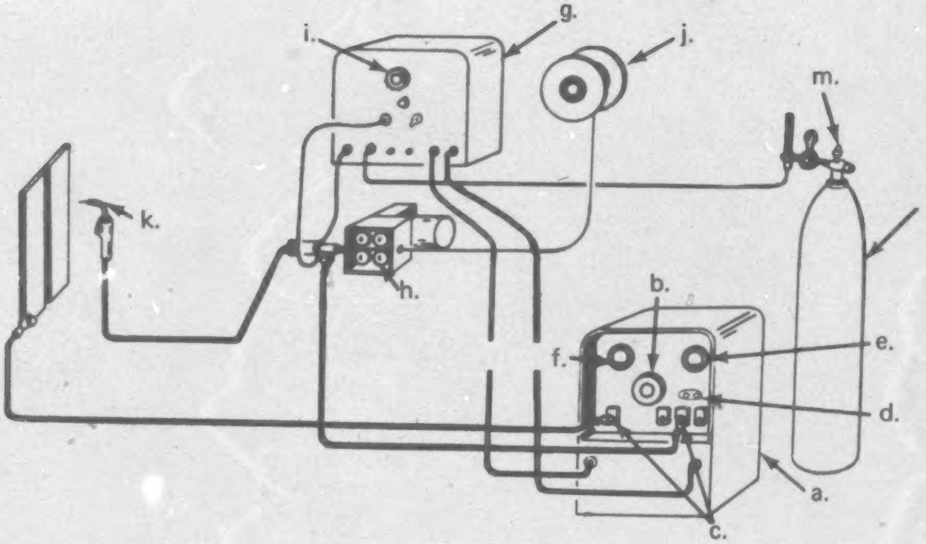
i.

j.

k.

l.

m.


i.
g.
j.
m.
k.
h.
b.
e.
f.
d.
a.
c.

4. Select from the following list three applications of the GMAW process. (Place an "X" in front of the application.)

_____a. Short circuiting (short arc)

_____b. Stick electrode

_____c. Spray arc

_____d. Gas welding

_____e. Flux cored wire

5. Name four factors to be considered when selecting a filler wire for the GMAW process.

a.

b.

c.

d.

6. Name the two types of mild steel welding wires used in GMAW welding.

a.

b.

7. Match the shielding gases to their use(s).

_____a. Used to weld aluminum and magnesium

_____b. Used to weld heavy sections of aluminum

_____c. Used to weld mild and stainless steel

_____d. Used for mild steel with short arc and flux cored application

_____e. Used on mild, stainless, and alloy steels and copper alloys

1. Argon-CO_2
2. Argon
3. Argon-Helium
4. Helium; Argon; CO_2
5. CO_2
6. Argon-Oxygen

8. Identify the causes of poor welds by matching the cause to the illustration.

_____a. Cold lapping

_____b. Excessive penetration

_____c. Insufficient penetration

_____d. Burn-through

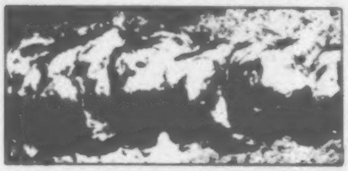
_____e. Surface porosity

_____f. Poor appearance

_____g. Whiskers

_____h. Bad tie-in

_____i. Suck-back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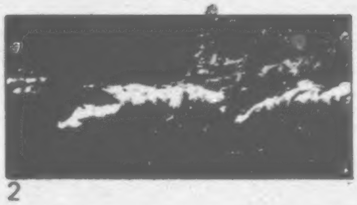
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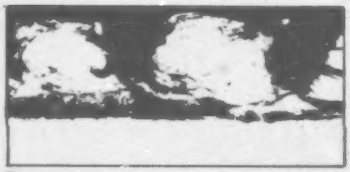
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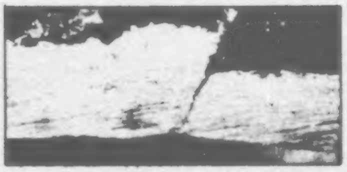
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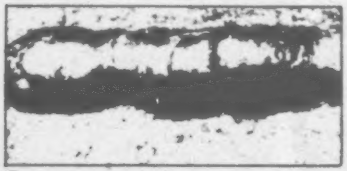
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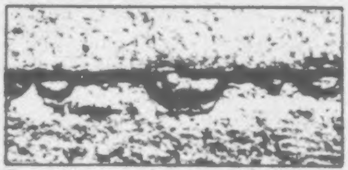
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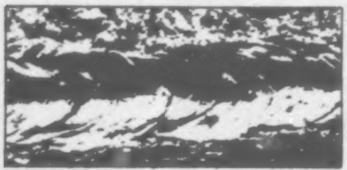
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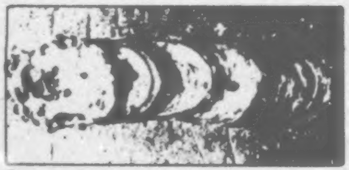
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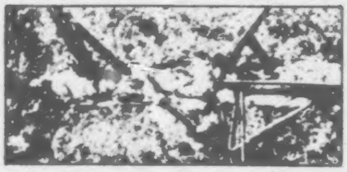
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9. List the characteristics of a good weld.

   a.

   b.

   c.

10. Name the two types of power sources for GMAW.

   a.

   b.

11. Describe the effects of electrode wire stick out on volts and amps.

   a. Increased stick out (long arc)

   b. Short stick out (short arc)

12. Demonstrate the ability to:

   a. Set up and shut down the GMAW equipment for short arc, spray arc, and flux cored arc welding applications.

   b. Construct a multiple pass T-joint fillet weld on 3/16" mild steel in the horizontal position with short arc.

   c. Construct a lap joint fillet weld on 3/16" mild steel in the vertical down position with short arc.

   d. Construct a square groove butt joint on 3/16" mild steel in the flat position with short arc.

   e. Construct a square groove butt joint on 3/16" mild steel in the horizontal position with short arc.

   f. Construct a multiple pass T-joint fillet weld on 1/4"-3/8" mild steel in the vertical up position with short arc.

   g. Construct a corner joint fillet weld on 1/4" mild steel in the vertical up position with short arc for break test.

   h. Construct a square groove butt weld on 3/16" mild steel in the vertical up position with a short arc.

   i. Construct a T-joint fillet weld on 1/4" mild steel in the overhead position with short arc for break test.

   j. Construct a square groove butt weld on 3/16" mild steel in the overhead position with short arc.

k. Construct a T-joint fillet weld on 16 ga. mild steel in the horizontal position with short arc.

l. Construct a single V-groove butt joint on 3/8" mild steel in the horizontal position with short arc for test.

m. Construct a single V-groove butt joint on 3/8" mild steel in the vertical down position with short arc for test.

n. Construct a single V-groove butt joint on 3/8" mild steel in the vertical up position with short arc for test.

o. Construct a single V-groove butt joint on 3/8" mild steel in overhead position with short arc for test.

p. Construct a multiple pass lap joint fillet weld on 1" mild steel in the horizontal position with spray arc.

q. Construct a multiple pass V-joint fillet weld on 1" mild steel in the flat position with flux cored wire.

r. Construct a T-joint fillet weld on 1/4" aluminum plate in the horizintal position with short arc.

s. Construct a multiple pass T-joint fillet weld on 1/4" aluminum plate in the vertical up position with short arc.

t. Construct a T-joint fillet weld on 1/8" stainless steel in the horizontal position with short arc.

u. Construct a square groove butt weld on 1/8" stainless steel in the flat position with short arc.

(NOTE: If this has not been accomplished prior to the test, ask the instructor when the above activities should be completed.)

GAS METAL ARC WELDING
UNIT II

ANSWERS TO TEST

1. a. 11
   b. 15
   c. 13
   d. 14
   e. 10
   f. 9
   g. 2
   h. 4
   i. 7
   j. 1
   k. 3
   l. 5
   m. 8
   n. 12
   o. 6
   p. 16

2. Any six of the following
   a. Arc always visible to the welder
   b. No slag and a minimum amount of spatter
   c. High disposition rates with 95% of the welding wire deposited in the joint
   d. Weld metal deposit of low hydrogen quality
   e. Wide range of metal thicknesses can be welded without changing wires
   f. Excellent for bridging gaps or misaligned joints without burn-through

g. Greatly reduced distortion in gage metal

h. Adaptable to weld most any metal by the selection of the correct filler wire and shielding gases

i. Adaptable to either automatic or semi-automatic

3. a. Power supply

b. Voltage control

c. Welding terminals

d. Power on-off switch

e. Volt meter

f. Amp meter

g. Wire feed control system

h. Feed rolls

i. Wire feed control (amperage)

j. Wire reel or coil

k. Gun

l. Shielding gas

m. Flowmeter

4. a

c

e

5. a. Metals to be welded

b. Metal thickness and joint design

c. Metal surface condition

d. Specifications of the job

6. a. Solid

b. Flux cored

7. a. 2

b. 3

c. 1 and 4

d. 5

e. 6

8. a. 4

b. 5

c. 6

d. 3

e. 8

f. 1

g. 9

h. 2

i. 7

9. a. Even ripple on bead

b. Slight crown (convex) at root

c. Well fused throughout joint

10. a. Transformer-rectifier

b. Engine or motor generator

11. a. Increases arc volts and decreases amps

b. Increases amps and decreases arc volts

12. Performance skills will be evaluated to the satisfaction of the instructor.